

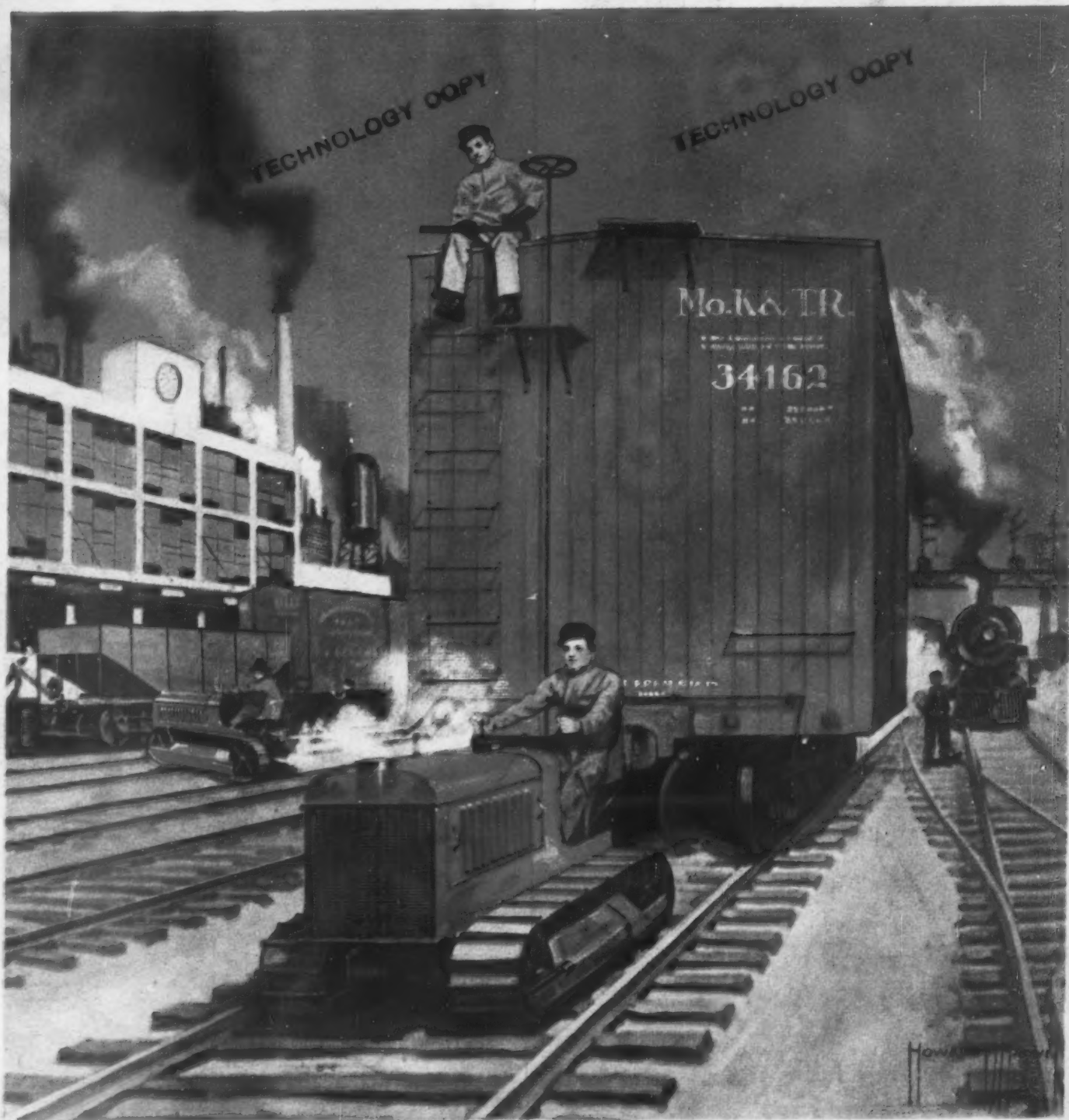
# SCIENTIFIC AMERICAN

*The Monthly Journal of Practical Information*

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APRIL 1923

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WHEN THE GASOLINE TRACTOR TAKES THE PLACE OF THE SWITCHING LOCOMOTIVE.—[See page 236]

Scientific American Publishing Co., Munn & Co., New York



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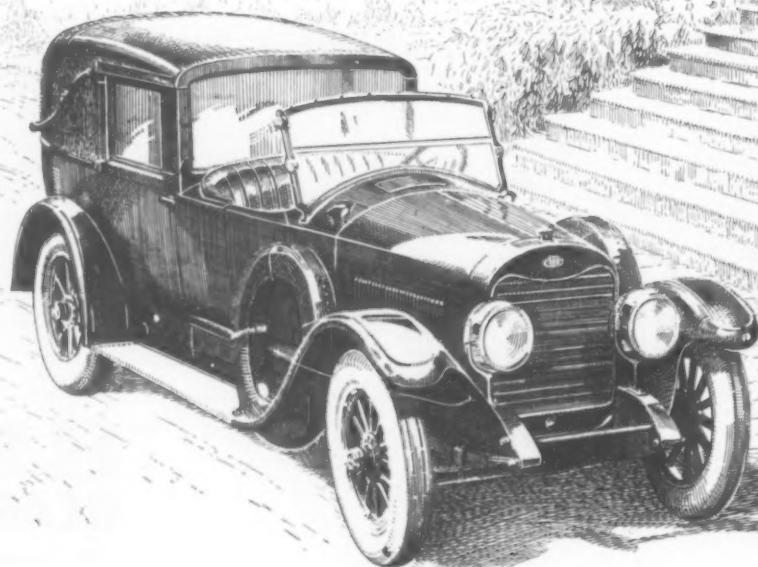
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Whatever may be the attributes which attract you to this motor car, with every mile that passes you will become more firmly mindful of the deep-rooted quality which is, after all, the key to every excellence it embodies.

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LINCOLN MOTOR COMPANY  
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# L I N C O L N



# With the Editors

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THIS issue opens up with an interesting and able discussion of the big and fast liners of the present and the future. After all, we must realize that the time has arrived in the design and the construction of ocean liners when speed and size cannot be increased without running into serious obstacles. Ever since the day of the early ocean liners, this journal has been chronicling the appearance of a larger liner and a still larger liner, as well as a fast liner and a still faster liner, culminating with the giant "Majestic" with accommodations for 3100 passengers, and the "Mauretania's" fast trip at an average speed of 26 knots. But today, if we interpret the signs correctly, the limit has been reached. Designers and constructors of ocean liners have abandoned their quest of the superlatives in ocean travel, and instead have turned to the task of designing and constructing more economical liners, the performance of which will be judged by the receipts and disbursements on the operating company's books. With a view to confirming our growing convictions that the limit has been attained in giant liners and fast liners, we asked Dr. Ernst Foerster, the well-known marine architect of Hamburg, Germany, to write an article for us dealing with the present and the future aspects of ocean travel. Dr. Foerster, by the way, is the designer of the hulls of the "Majestic" and the "Leviathan." The result of our request is the opening article in this issue, which will be found of more than usual interest.

JUST as Dr. Foerster, in his able article, has looked into the future of ocean transportation and has told us what he sees, so we intend to have other leaders in various lines of endeavor prophesy what lies ahead of us. It is because the future is always more interesting than the past or present that we shall endeavor to carry an occasional article of a prophetic nature, although the task is by no means underestimated. Highly imaginative writers of fiction, such as H. G. Wells of today and Jules Verne of yesterday, have had no unreasonable difficulties by way of leading their readers into future ways; and they have been amply rewarded for their intrepid thoughts and writings. But fiction is one thing and cold scientific fact is quite another. In these columns we have no space for unfounded visions and exciting adventures of the future. We are dealing with crisp, clean-cut actualities of the present, and such attention as we may devote to the future must be given to sound probabilities. So, to satisfy our craving for an occasional glance into the future yet with an unrelenting grasp on scientific accuracy, we are arranging to secure the views of well-known men in various walks of science, as regards future developments. These men—men who are doing real things—can tell with almost certain accuracy what is to happen in their respective fields of endeavor in the near future. Many of them are at work on problems in their laboratories, and it requires no great stretching of imagination for them to tell us what will be the effect of these present developments, now incubating in the laboratory, when they are introduced into the workaday world. In other words, they need do little more than project the trends and tendencies of today into the future, in order to give us a true picture of what is ahead. Of this particular kind of subject, there may be an occasional article now and then.

YOUR daily newspaper has furnished you with no little news regarding the Washington Naval Treaty and the general subject of the reduction of armaments. At least, the newspapers in general have done their work well by way of keeping the public informed as regards the diplomatic and political aspects of this great movement. Yet behind the meetings of the plenipotentiaries and their worthy discussions and their signatures to the Treaty, followed by the political maneuvers in the various contracting countries, there is the great story of the actual enforcement of the terms of the Washington Naval Treaty. And it is in this particular that the newspapers have as yet told us little. What have the various contracting parties done by way of carrying out their respective obligations? How many warships have been dismantled? What kind of warships are being scrapped? These and other questions have occurred to many of us, and we have sought answers in our daily and periodical press. But the first authentic information regarding the actual carrying out of the Treaty, so far as we know, is contained in this issue. Our British correspondent, Mr. Hector C. Bywater, secured the data which served as the basis of our center spread drawing and the tables.

ONE of those unfortunate errors which every so often crop up in the most unexpected corners of even the best-managed editorial household, has been brought to our attention by a Chicago manufacturer of check-writer and protector appliances. In the article entitled "Inventor vs. Forger" appearing in our January, 1923, issue, we published facsimile reproductions of a check drawn on the Citizens Banking Company of Sandusky, Ohio, before and after the raising operations. The caption appearing under the altered check, the lower one on page 8, unfortunately stated that there was nothing about the altered appearance sufficiently suspicious to raise any question, and the bank paid \$585.00 on it in the ordinary course of business. That caption was based on information which came with the facsimile photographs. It now turns out upon thorough investigation that the check in question was given to a forger, while he was incarcerated in a Western penitentiary, for the purpose of demonstrating his skill. The results of his criminal handcraft are shown in the second reproduction. However, the altered check was never sent through the bank, since its sole object was to serve as a demonstration of check raising. We regret the error and hereby retract that part of the caption which reads "and the bank paid \$585.00 on it in the ordinary course of business."

RESPONSES from our readers to the February editorial, "The Engine as a Brake," have been unusually numerous and unusually interesting. Indeed, it seems almost that everybody who writes has thought of something that has occurred to nobody else, and our gentle suggestion that the cycle of operation in a dead engine is complicated is amply borne out. We are not sure at this moment whether we shall present these letters on our correspondence page, or whether we shall not find them of sufficient interest and importance to warrant assembling them into a special article. In any event, after the returns from the second editorial of March on this subject are in, we shall do the one or the other.



**ST. LOUIS DIVISION**  
The territory served by the St. Louis Division includes Southern Illinois, Missouri, and Arkansas.

**NEW ORLEANS DIVISION**  
The territory served by the New Orleans Division includes practically all the Southern States.

## A Year Ago—And Now

**M**ARCH, 1922, marked the formation of the General Box Company—an organization comprising seventeen box factories in different sections of the country.

It was a new development in an age-old industry—not only based on the premise that a box manufacturing institution, operating on a national scale under one management, could render a real economic service, but also that such a service was an economic necessity.

Such an organization held many interesting possibilities. However, they were only possibilities then—founded, of course, on facts, but unsupported by any precedent in the wooden box industry.

★ ★ ★ ★

Now, after one year, it is definitely established that our original premise was right and General Box Service is a matter of fact and not of theory.

Sales have developed beyond our expectations and are forging ahead in a most satisfactory manner. But this point, gratifying as it is, does not measure up to the full satisfaction derived from our record of service.

Only in special emergencies is the capacity of an organization for rendering a thoroughly dependable service tested out and its strength or weakness exposed. During the serious freight car shortage that existed a few months ago—and still does, only to a lesser degree—the strength and flexibility of General Box Service was shown clearly and unmistakably. In many instances we were able to make quick shipments to customers who had to have shipping boxes almost immediately. Through our ability to manufacture and ship from any one of seventeen cities, we were

*If you will write us we will be glad to send a competent engineer to help you in analyzing your container requirements. This puts you under no obligation of any sort. It is part of our service extended to all shippers East of the Rocky Mountains. We make all types of wood boxes. The advice of our engineers is, therefore, unprejudiced.*

able to prevent serious annoyance and possible loss not only to our customers but also to their customers.

With all factors of administration, of purchasing, of production and of sales now fully co-ordinated, our achievements of last year are but a stepping stone in our development of an unusually broad and constructive boxing and crating service.

★ ★ ★ ★

Authorities acknowledge that hundreds of millions of dollars are lost annually because of the use of poor or improperly designed shipping containers.

That this is true is confirmed by the experience of those shippers who have adopted scientific boxing and crating methods.

McQuay-Norris Manufacturing Company, after intelligent investigation, adopted the Pioneer (Wirebound) Box at the recommendation of one of our box engineers. In doing this they have, according to their own report, eliminated damage claims; reduced the container weight to a minimum—thereby reducing freight and express charges; prevented theft of goods in transit and, at the same time, furnished their jobbers with a box that could be re-used by them.

This instance is typical of what has been done for hundreds of shippers. It is the natural result of specialized knowledge applied to a particular problem.

★ ★ ★ ★

G. B. C. Service—a bulletin of information on better boxing and crating—will be sent to anyone interested in this subject. Please address your reply to 40 West Illinois Street, Chicago, Illinois.

# GENERAL BOX COMPANY

40 WEST ILLINOIS STREET - CHICAGO

**FACTORIES AT**  
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Brooklyn, N. Y.  
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Crawfordsville, Ind.  
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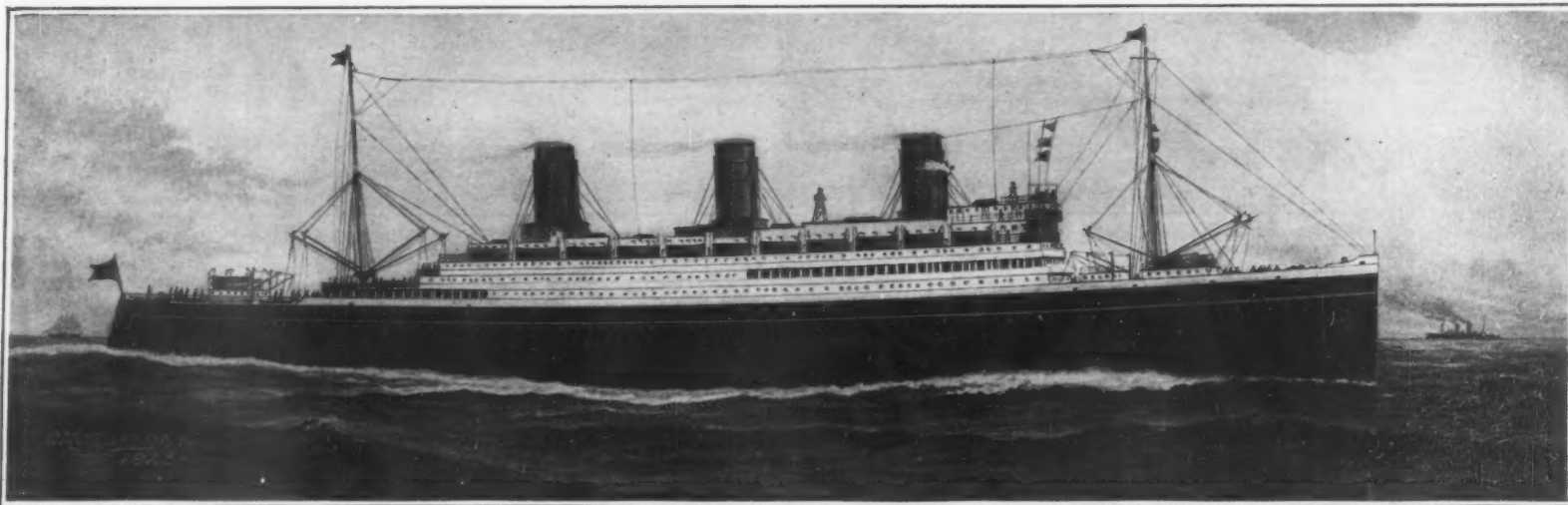




# SCIENTIFIC AMERICAN

THE MONTHLY JOURNAL OF PRACTICAL INFORMATION

NEW YORK, APRIL, 1923



Although the ship shown above would be of 6800 tons less displacement and 11,000 less horsepower than the "Majestic," and would require 1135 tons less oil on each trip, she would carry 1146 more passengers at the same sea speed of 23 knots

Design for an improved "Majestic"

**T**HE highest point in the development of the North Atlantic passenger traffic by means of large and fast liners was reached in the summer of 1922, when two passages, of about 25 knots average speed, were performed by the "Mauretania" of the Cunard Line, built by Swan, Hunter & Wigham Richardson, and the "Majestic" (ex "Bismarck") of the White Star Line, a sister ship of the "Leviathan" (ex "Vaterland"), both built by Blohm & Voss. The "Majestic" did the passage in the shortest time, while the "Mauretania," running over a longer course, developed a speed slightly superior to that of the "Majestic."<sup>a</sup>

With respect to the modern and most economical design of turbines and boilers, as well as maximum passenger accommodation and maximum dimensions of the vessels, the "Majestic" and the "Leviathan" have to be regarded as marking the high level of development in the North Atlantic trade, distinctly showing the extreme limit under present conditions in the way of further progress.

The draught being almost 39 feet may not be increased for the next 10 or 15 years by much more than one foot, the draft being controlled by the depth of the main entrances to New York harbor as well as to Plymouth, Southampton and Cherbourg.

The length of the biggest vessel being 954 feet over all, cannot reasonably be increased by any considerable amount; for it is limited by the present length of the piers in the North River. Furthermore, any increase in length, draft, and size will increase the difficulties of handling and navigation.

Even stronger is the argument against much larger and faster ships on the grounds of economy. If the "Majestic" and the "Leviathan" can now be run economically in these days of high cost of materials, supplies, and labor, it will be largely because they were transmitted to their present owners at figures far below their original price. Nevertheless, the question of bigger and faster ships has recently been discussed with much seriousness by the shipping world on both sides of the Atlantic, especially from those technical

<sup>a</sup>The "Mauretania" of 31,000 tons, and a maximum of 72,000 horsepower, holds the record of an average speed of 26.01 knots for the Atlantic passage.—Editor.

## Big and Fast Liners of the Future

By Dr. Ernst Foerster

Designer of the hulls of the "Majestic" and the "Leviathan"

points of view which provide a basis for the policies of the shipping companies.

The most important technical question bearing on progress is that of the propelling machinery. The promising development of the internal-combustion en-

gine (on the Diesel principle) has in some quarters created illusions with respect to future possibilities, which, in the direction of Diesel reciprocating engines, do not appear to be based upon sufficient grounds. As to the gas turbine, there is

nothing in the success so far achieved in experimental work to warrant the conclusion that this type can be applied for many years to come as a drive for large and fast Atlantic liners.

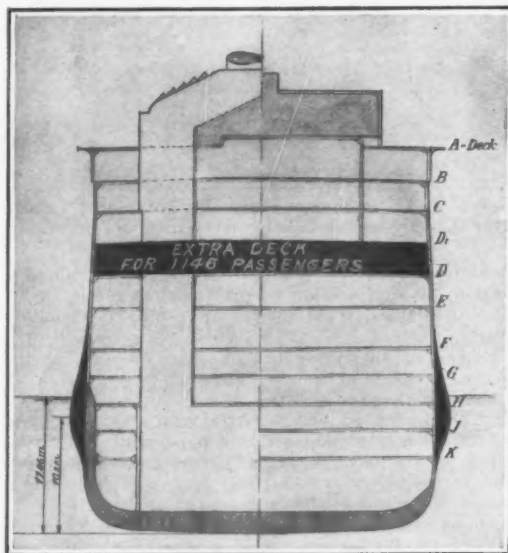
However, the development of the geared steam turbine has reached a point where it would be possible to build a "Mauretania," a "Majestic," or a "Leviathan" that would show an economy of operation far superior to the existing vessels that carry those names. The saving in weight and space, as well as the smaller consumption of fuel oil on account of the far higher speed of revolution of the main turbines, has established, without any doubt, the wisdom and practicability of applying the geared drive to the big liners of the future.

Profiting by the advantages of the reduction gear, there are two diverging directions for future development: one aiming at a higher speed, the other economizing the management to the highest possible degree.

In considering the question of higher speed, the question is, how far may this be carried; what will be the saving of time accomplished; and will this shortening of the passage justify the far greater cost of construction and operation? Adopting a maximum possible speed of 29.12 knots and an average ocean speed of 28.35 knots, we get the following results:

On the Winter Course, the passage between Ambrose Channel and Cherbourg would be made in 4 days 15 hours; between Ambrose Channel and Plymouth in 4 days 13 hours. On the Summer Course the Ambrose Channel-Cherbourg course would be covered in 4 days 12 hours, and the Ambrose Channel-Plymouth course in 4 days 10 hours.

Going eastward in summer time it may be desirable to leave New York for Plymouth (or Cherbourg) one, (or three) hours later, in order to utilize the day of departure as a whole working day. In this case the average speed would have to be increased to 28.6 or 29.12 miles an hour, for which speed the propelling



Midship section showing the bulges at the waterline, which afford sufficient stability to permit the use of one deck more for passengers (shown shaded) than there are in the "Majestic." By this means the passenger accommodation is raised from 3100 in the "Majestic" to 4246 in the proposed ship, the speed (23 knots) being the same

Midship section of the proposed liner

machinery ought to be designed. The layman who is interested in these problems will be interested to know what kind of a ship must be designed to be big and powerful enough to ply between Europe and the United States, at a speed of 28 to 29 knots, with the regularity which characterizes the present ships. We take pleasure in laying down before the readers of this magazine a design which has been worked out with the support of the best qualified local experts who could be found for this purpose.

The accompanying table, showing three designs for transatlantic liners, shows propelling machinery, with single-reduction geared turbines and a water-tube boiler plant of 185,000 horsepower, for a liner very similar in dimensions to the "Leviathan," and having a speed of at least 29.12 knots on the trial trip. The reader will be interested to compare the necessary space for the propelling machinery (geared turbines) of the 29.12 knots ship with that of the "Leviathan" and the "Majestic," with straight-drive turbines. The latter ships require more space for half the power. The total weight of the power plant including boilers is 8200 tons for the "Leviathan," with 95,000 horsepower; it will be 12,000 tons for the 185,000 horsepower of the new design. The length of the turbine rooms in the "Leviathan" and "Majestic" is 150 feet, and in the new design of over twice the horsepower it is only 138 feet. The fuel economy will be better by at least 10 per cent per horsepower, on account of the high revolutions (1350 per minute) of the main turbines. The propellers will have 185 revolutions a minute.

The next higher speed which would have to be attained in order to secure a worthwhile lowering of the time of passage, would result in saving at least another 16 hours—the time of arrival then being altered from 8 a. m. to 4 p. m. of the preceding day, thus enabling the passengers and mail to reach London and Paris at the end of the fourth day of the passage. This could be obtained by a speed of 32-33 knots an hour. The design of such a ship must reasonably be based upon no relative diminution of passenger capacity in comparison with the present big liners. The minimum dimensions for the 33-knot vessel would be as follows: Displacement, 107,000 tons; length, 1120 feet; beam, 147 feet; draft, 39 feet; with propelling machinery of 380,000 horsepower. The realization of this design is very unlikely indeed. Even regarding the 29-knot boat, one may be very skeptical, although this condition may be fulfilled by a vessel of nearly the "Leviathan's" dimensions.

Discussing the very practical question of a further improvement of the traffic speed, it may be taken for granted that though there is only a very small percentage of passengers that has a considerable interest in this; there is a universal and permanent interest in a rapid mail service. To my mind there is no better answer to these questions than to state that the recent development of aircraft points to this form of transportation as the logical field in which to realize the higher speeds as they are demanded.

The Transatlantic rapid mail service by aircraft is being seriously discussed, as well for the North Atlantic as for a route Spain-Azores-Brazil-Argentina. It cannot be denied that today this problem is no longer in the field of mere speculation. Its solution is merely "a question of time." The technical data are today sufficiently known, being based upon practical experience, to allow an "extrapolation" without laying its promoters open to the reproach of pursuing fantastic ideas.

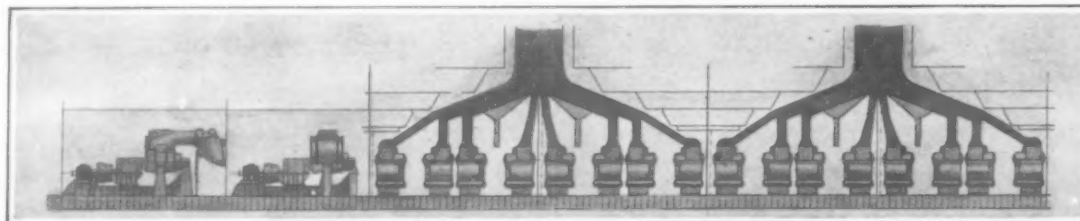
Having supposed and admitted this much, we shall have to discard the idea of future 29 and 33-knot liners and try to achieve a speed of 65 knots in the air, this being a normal and economical air-speed which is quite practicable. The decisive question again is: Would it pay its way?

The last word upon this subject may justly be accorded to the "Luftschiffbau Zeppelin" of Friedrichshafen, a company which may not only claim the longest and greatest experience in the building of airships, but is now constructing what will be the biggest airship in existence. This is a cruiser for the United States Navy, with a capacity of 2,500,000 cubic feet.

This airship, not being intended for long transatlantic voyaging, will have a carrying capacity not exceeding the necessary weights for fuel, provisions, crew, etc., required for her duties.

She will be equipped with a power plant of about 2000 horsepower, giving her a speed of about 65 knots, and enabling her to fly from Friedrichshafen to Washington in 65-70 hours, provided the wind and weather conditions are about normal.

Based upon the design of this vessel, the minimum size of a transatlantic airship, capable of taking 40 passengers and 12 tons of mail, will be of 5,000,000 cubic feet capacity. The dimensions would be as follows:



Elevation showing engine and boiler rooms necessary to drive an enlarged "Majestic" at 28.35 knots sustained sea speed. (For plan view see below)

Greatest length, 820 feet; greatest diameter, 110 feet; number and power of motors, 9 of 400 horsepower (See illustrations, page 223).

Fuel for 3500 miles, and 25 per cent reserve with respect to any possible contrary winds of a constant speed of 26 feet per second, as well as provisions, water, etc., is 50 tons. This leaves a net carrying capacity for mail, etc., of 12 tons. Number of passengers, 40 persons.

Four of these ships and one in reserve would be sufficient for a regular transatlantic mail service, with departures from both sides every third day. This would mean an annual total of 2400 tons of mail and 8000 passengers.

The initial cost of five ships, calculated on the present basis of German wages and cost of material, would be \$9,000,000. All necessary harbor work, the sheds and all appliances for handling, securing, repairing and managing the ships would cost another 22 million dollars.

The actual cost of running the ships, including all

fect on the growth of all commercial relations between the two continents.

The future development of rapid transatlantic service will, no doubt, be influenced in a decisive way by the progress of safety attainable by airships. Satisfactory experience in this direction will mean that the maximum speeds of future liners will be confined at least to the present standard.

When the time has come to create a new and improved type of liner for the North Atlantic trade, the question of speed will probably no longer be the most important part of the problem; but the aim will be to design the most economical vessel for the "moderate" speed of 22-23 knots. The greatest promise of economical progress is afforded by the geared steam turbine. A new "Leviathan" confined to the above named speed (without the unnecessary excess of weight in the propelling machinery) would have a power plant of 55,000-60,000 horsepower, weighing 5200 tons instead of 8200 tons, which is its weight in the case of the "Leviathan." On account of the corresponding rise of the center of gravity, it would be necessary to increase the beam of the vessel by two feet.

The only—but prohibitive—obstacle to ensuring a considerable improvement of the running economy of the fast liner of the future by increasing her useful superstructures for passenger accommodation without increasing the dimensions, is the question of stability.

The difficulties of solving this problem have given rise to the idea of a certain alteration in the midship section, widening the latter at, above, and beneath the water-line as far as necessary, in order to provide for an ample range of increased stability, without increasing the beam throughout the height of the ship. This scheme was first adopted in the case of a small paddle steamer in 1910, then for a big liner in 1914, this being the 20,000-ton River Plate steamer "Cap Polonio," then approaching completion, which was provided with bulges at the water-line for compensating additional weight in the top superstructures. Subsequently the two new 22,000-ton Hamburg-American liners "Albert Ballin" (launched December, 1922) and "Deutschland" (to be launched March, 1923), both now building by Blohm & Voss, were designed according to this principle. This scheme ensures an increase of running economy, as proved by model research work in the towing tank. It is worth noticing, that in a part of the

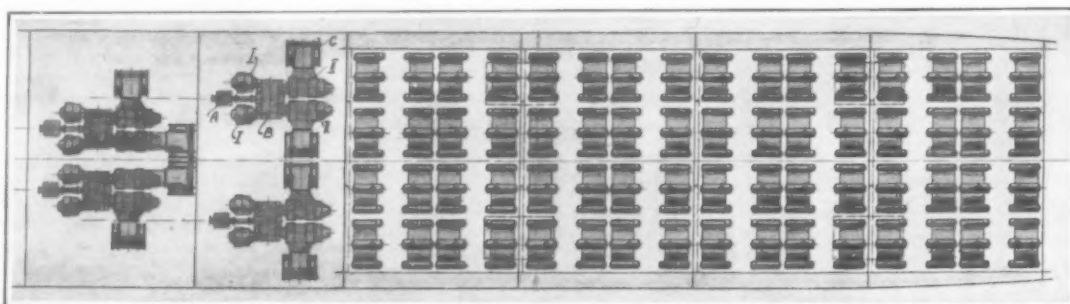
length of the bulges, anti-rolling tanks (Frahms Patent) are provided, which have no overflow channels across the ship's hold, but have openings in the outside plating by which the water has a direct connection to outboard.

By an alteration of the midship section by means of bulges extended over three-quarters of the length of the vessel, quite a new basis is created for the maximum possible amount of useful superstructures.

A new "Leviathan," with bulges 6 feet wide on each side, could carry an additional deck on the ship's whole length, providing space for 1146 additional passengers of the first, second and third classes. The stability would be equal to that of the "Leviathan." The additional weight of 5000 tons would be compensated for partly by the saving of 3000 tons in the machinery (as mentioned above), partly by the additional displacement on account of the increased beam and of the bulges. It has been proved by model research work, that the bulges improve the qualities of any model at the higher speeds. Taking everything together, the economy of the ship is decisively improved by this device.

By adding a height of nine feet (on one deck) the safety of the vessel is considerably increased with respect to unsinkability; for the bulges provide a decided protection to the water-line in case of collision.

The addition of a whole deck would make it necessary to increase the beam in a normal form by at least

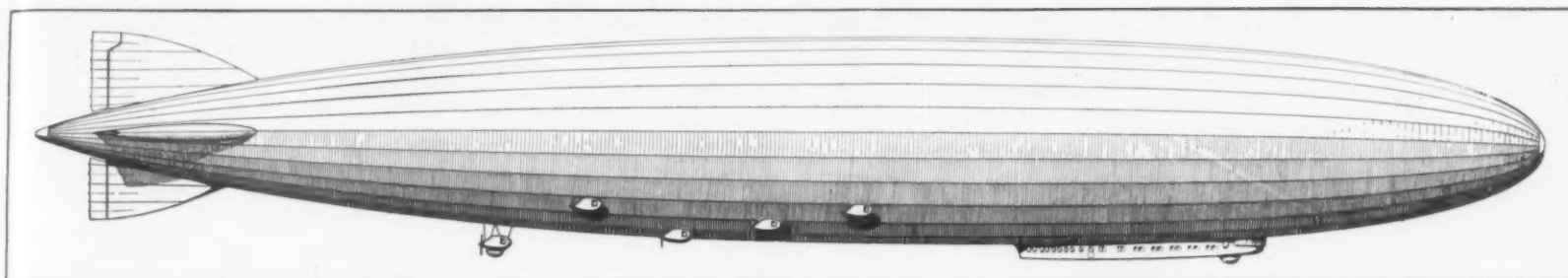


Plan view of the engine and boiler plant necessary to drive an enlarged "Majestic" across the Atlantic at 28.35 knots. To supply steam for the turbines of 165,000 horsepower would require 64 water-tube boilers

mortgage service (40 per cent on the ships), administration, all expenses on personal and material, insurance and duties, would amount to 11 millions of dollars yearly.

Supposing that 31½ millions are invested in the company, and that rough interest on this sum (after paying all the cost specified above) be at least 23 per cent, it would be necessary to earn  $11 + 7.2 = 18.2$  million dollars a year. This can be realized, if two-thirds of the total passenger capacity (5300 a year), and three-quarters of the mail capacity (1800 tons a year), are utilized—the necessary rates being \$550 for each passenger and \$0.17 for each letter of 20 grams or \$8.5 for 1 kilogram. Such a passenger rate would be twice the present rate for good berths on big liners, and the mail rate considerably more. However, a liner even of 28.4 knots would have to charge at least similar rates; the "four-day liner" would have to charge much more, and it may be supposed that a passage of two days and a half would be not only most attractive to passengers, but would also exercise a powerful ef-





Transatlantic air liner, 820 feet long, 110 feet diameter, capable of carrying 12 tons of mail and 40 passengers at a speed of 65 knots

13 feet, involving a corresponding addition of 6400 tons of weight, including the additional weight for the necessary increase of propelling power by 5000 horsepower, this meaning about 10 per cent on the initial and on the running cost of the vessel, if built on a "no rush" scheme.

The new vessel shows a cruiser stern as a characteristic of a modern liner, this giving ample space, increased stability, less vibration, and higher efficiency of propellers. The ship also carries a new type of rudder (Fleetner Rudder) which at present is being introduced into the world's shipping. The application of this rudder makes it possible to dispense with the steering engine of 700 horsepower, substituting a motor of 5-6 horsepower, this being placed in the compass house on the bridge.

By way of recapitulation it may be said, that we are a long distance off the desired "four-day liner," the airship being more likely to take this job in hand. For shipping it may be the master problem to create a type of unrivalled economy, which in speed and dimensions is based upon the design of the "Leviathan" and the "Majestic," but is improved in the propelling machinery and in the design of the hull as above mentioned, and further developed in many details and essential features.

Such an improved "Leviathan," as our table shows, would carry 1146 more passengers than that vessel. Her propelling machinery would weigh 3000 tons less; she would load up with 1700 tons less oil; and her sea speed would be the same.

#### Atoms: Their Size and Number

THAT matter is discontinuous and consists of discrete particles is now an accepted fact, but it is by no means obvious to the senses. The surfaces of clean liquids, even under the most powerful microscope, appear perfectly smooth, coherent, and continuous. The merest trace of a soluble dye will color millions of times its volume of water. It is not surprising, therefore, that in the past there have arisen schools which believed that matter was quite continuous and infinitely divisible.

The upholders of the view said that if you took a piece of material, lead, for example, and went on cutting it into smaller and smaller fragments with a sufficiently sharp knife, you could go on indefinitely. The opposing school argued that at some stage in the operations either the act of section would become impossible, or the result would be lead no longer. Bacon, Descartes, Gassendi, Boyle, and Hooke were all partial to the latter theory, and Newton in 1675 tried to explain Boyle's Law on the assumption that gases were made up of mutually repulsive particles.

The accuracy of modern knowledge is such that we can carry out, indirectly at least, the experiment sug-

gested by the old philosophers right up to the stage when the second school is proved correct, and the ultimate atom of lead reached. For convenience, we will start with a standard decimeter cube of lead weighing 11.37 kilograms, and the operation of section will consist of three cuts at right angles to each other, dividing the original cube into eight similar bodies, each of half the linear dimensions and one-eighth the weight. Thus the first cube will have 5 cm. sides and weigh 1.42 kilograms, the second will weigh 178 g., the fourth 2.78 gm., and so on. Diminution in the series is very rapid and the result of the ninth operation is a quantity

mind is staggered by their immensity. Thus if we slice the original decimeter cube into square plates one atom thick the area of these plates will total one and one-quarter square miles. If we cut these plates into strings of atoms spaced apart as they are in the solid, these decimeter strings put end-to-end will reach 6.3 million miles, the distance light will travel in a year, a quarter of the distance to the nearest fixed star. If the atoms are spaced but one millimeter apart the string will be three and a half million times longer yet, spanning the whole universe.

Again, if an ordinary evacuated electric light bulb were pierced with an aperture such that one million molecules of the air entered per second, the pressure in the bulb would not rise to that of the air outside for a hundred million years. Perhaps the most striking illustration is as follows: Take a tumbler of water and—supposing it possible—label all the molecules in it. Throw the water into the sea, or, indeed, anywhere you please, and after a period of time so great that all the water on the earth—in seas, lakes, rivers, and clouds—have had time to become perfectly mixed, fill your tumbler again at the nearest tap. How many of the labelled molecules are to be expected in it? The answer is, roughly, 2000; for although the number of tumblersful of water on the earth is  $5 \times 10^{21}$ , the number of molecules of water in a single tumbler is 10.25.—Abstract from article by F. W. Aston, in *Nature*, November 25.

#### A Fungus Bomb

AT Valenciennes, France, two people have been rendered so ill by the bursting of a giant fungus that medical aid was required. The fungus was a huge puffball (*Calvatia*), a species which is often considerably larger than a man's head. The fungus which was growing in the wainscoting of a workman's cottage suddenly burst open releasing enormous numbers of spores. An idea of the vast quantities of spores produced by these puffballs may be gathered from the fact that one specimen examined at the Birmingham University, England, was calculated to have produced no less than 7,000,000,000,000. Many puffballs release their spores through a small opening at the top, but the *Calvatia* split right open more or less suddenly. The spores of these fungi have an intensely irritating effect on the lining of the nose and throat and it can be believed that the sudden bursting of a large *Calvatia* in a small apartment would have most unpleasant effects.

Formerly, we now learn, the spores of puffballs were used in place of snuff, seeing that a small pinch would bring on the most violent sneezing. The *Calvatia* often turns up in most unexpected places and will grow where there is any damp material like rotting wood or suitable soil and moss.

#### Comparison of Three Designs for a Transatlantic Liner

Ship	1	2	3
	Present biggest type of fast liner	4½ days liner	Most economical liner of present speed
	"MAJESTIC"	Design	Design
Average ocean speed (knots).....	22.5-23	28.35	22.5-23
Max. speed (across ocean) (knots)	24.95	29.12	23.5
Propelling machinery normal (hp.)	66,000	165,000	55,000
Propel. mach'ry exceptional (hp.)	95,000	185,000	60,000
Length on the water line (m.)....	285	299	274
Length over all (m.).....	291	303	277
Beam (m.) .....	30.5	34.0	31.1-34.8†
Maximum load draft (m.).....	11.86	11.86	11.70
Maximum displacement (t.).....	64,600	72,800	57,800
Weight of hull complete (t.).....	41,000	48,000	44,600
Weight of propelling mach'ry (t.)	8,200‡	12,000§	5,200§
Fuel oil, leaving New York (t)....	6,000	7,700¶	4,300
Feed water, fresh water, provisions mail, baggage, crew, equipment for ship and machinery (t.).....	5,100	5,100	4,600
Displacement leaving N. Y. (t.)...	60,300	72,800	58,700
Accommodation for passengers...	3,100	3,300	4,246

\*Ex "Bismark" is identical to "Leviathan" (ex "Vaterland") except that she is six feet longer than the latter.

†Normal beam increased by bulge to compensate diminution of stability due to smaller propelling machinery.

‡Direct acting turbines.

§Geared turbines.

¶For one passage and a half; additional bunkering for half a passage taken aboard at European station.

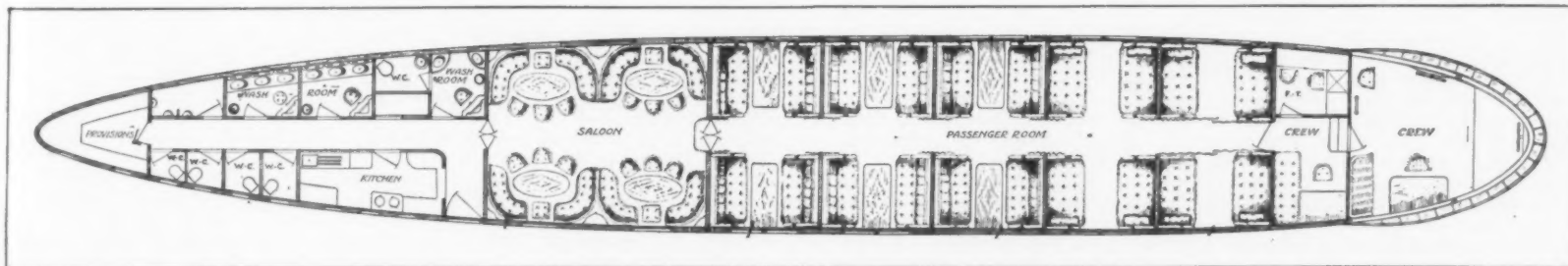
||Fuel for one passage only.

of lead just weighable on the ordinary chemical balance. The last operation possible, without breaking up the lead atom, is the twenty-eighth. The twenty-sixth cube contains 64 atoms, the size, distance apart, and general arrangement of which can be represented with considerable accuracy, thanks to the exact knowledge derived from research on X-rays and specific heats.

Just as any vivid notion of the size of the cubes passes out of our power at about the twelfth cube—the limiting size of a dark object visible to the unaided eye—so when one considers the figures expressing the number of atoms in any ordinary mass of material, the

the top, but the *Calvatia* split right open more or less suddenly. The spores of these fungi have an intensely irritating effect on the lining of the nose and throat and it can be believed that the sudden bursting of a large *Calvatia* in a small apartment would have most unpleasant effects.

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Cabin plan showing passenger accommodation on the air liner shown above



**H**OW WOULD be a rash dogmatist who should assert that never, no never, will science make the official weather forecaster's job superfluous by taking over from Mother Nature the business of supplying weather to humanity. On a small and local scale, the feat of artificial weather making is even now accomplished every day. Within the walls of our dwellings we substitute summer for winter as regularly as the season demands and as coal strikes will let us. When damaging frosts threaten we temper the atmosphere of our orchards with heating devices. By planting trees to serve as windbreaks we materially alter the climate of a prairie farm, with respect to wind, moisture and temperature. Sometimes our achievements in atmospheric juggling are unpremeditated, as when we carelessly set a forest on fire, and the conflagration gives rise to a shower of rain. Since the wholesale regulation of weather is a desideratum of the utmost importance (consider what it would mean merely to abolish drought in the agricultural regions of the world), we may cherish the hope that some day science will solve the problem, though by ways that are now quite out of sight.

There have, however, been plenty of reported achievements in this field that, on investigation, turn out to be illusory. Since the rise of aviation, one of the favorite aspirations of weather-makers, including men of high scientific standing, has been to find a means of dispelling fog, especially in the neighborhood of flying fields and landing grounds. Three general methods have been proposed and rather fully discussed; viz., (1) to drain away the fog-laden air and replace it by fog-free air from above; (2) to warm the air, and thus evaporate the cloud particles; and (3) to precipitate the fog by means of electrical discharges. All three methods are feasible under laboratory conditions. None of them have hitherto proved valuable for practical purposes, because to carry them out on a large scale would entail absolutely prohibitive expense.

Now we are asked to believe that a method of dispelling clouds and fog, and incidentally of turning clouds into rain, cheap enough to be applied universally for the benefit of aviators and others, has been devised by Prof. Wilder D. Bancroft, of Cornell University, and Mr. L. Francis Warren, whose experiments were conspicuously reported in press dispatches dated Feb. 11 and 15. The investigators have been at work at McCook Field, near Dayton, Ohio, at intervals during the past year and a half, their experiments being conducted on behalf of the Army Air Service. The process consists of spraying the clouds from an airplane with electrically charged sand. This procedure is claimed to have quite startling effects in accelerating the coalescence of the cloud particles into drops large enough to fall rapidly, thus clearing away the cloud and producing an incipient rainstorm. According to the *New York Times*:

"The airplane is equipped with a wind-driven electrical generator to furnish the electricity used to charge the sand. The sand is forced through a nozzle. The grains acquire their electrical charge just as they emerge. They are flung far and wide by the propeller of the plane. The cloud is bombarded with charged

## Sand-Blasting the Clouds for Man-Made Weather

particles of the opposite sign to that of the cloud at the rate of trillions per second. If these particles are scattered or repelled from the roof of the cloud, the flier knows that he is using positive sand on a positive cloud or negative sand on a negative cloud. The pull of a switch makes the necessary change in the electrifying apparatus, and a blast of oppositely charged sand is released. Then the cloud begins to disintegrate."

In a more recent communication addressed to *Science Service*, Dr. Bancroft offers the following explanation of the effects claimed to have been produced by this process:

"Clouds consist of drops of water too small to fall at an appreciable rate. Drops are kept from coalescing either by being charged electrically and thereby repelling each other or by being covered with a film of condensed air acting like a gelatine capsule. Spraying with positively charged sand will cause negatively charged drops to coalesce and will also remove the film of absorbed air to some extent. The first is the principle involved in precipitating electrically charged colloids and the second occurs when the crystal detector is used in wireless. The large drops fall and carry with them many of the finer drops, just as the coarser particles of butter fat in milk carry up many of the finer ones when cream rises.

"The new process invented by Warren sprays electrically charged sand from above and consequently gets more results for the same expenditure of power the thicker the cloud. Experiments at McCook Field show that with 80 pounds of sand charged nominally to 15,000 volts a cloud covering two square miles can be dissipated in less than 10 minutes. Much better results are expected with sand charged to 30,000 volts and a more efficient charging nozzle.

"The experiments so far have been made in cooperation with the Army Air Service to demonstrate the feasibility of removing fogs from flying fields. Experiments to be made at Moundville will use a captive balloon 1000 feet up to spray the sand and clear the field. Flying fields can certainly be kept clear, and the results look encouraging for clearing New York harbor when necessary. . . .

"The Army Air Service is interested in fogs, not rain, and no experiments on rain-making have yet been made. The clouds attacked so far have contained very little moisture. The problem of obtaining rain from heavy clouds should be much easier than dispersing fogs. No claim is now made that rain can be obtained from a clear sky. In many of the arid regions storm clouds pass over without raining. These can undoubtedly be made to rain. With a rain cloud one mile thick the necessary expenditure of power will be the same as with a cloud 300 feet thick, but the amount of rain will be very much greater. The problem of rain-making and of fog dispersal consists of making small drops into large drops by coalescence, and is not a problem of condensation."

The process above described is certainly ingenious and contains some elements of novelty. There was at least one earlier case on record in which dust was

thrown upon clouds from an airplane with a view to provoking rain, under the mistaken idea that the more dusty nuclei in the air the better the chance of rain. As a matter of fact, as Dr. W. J. Humphreys pointed out a few years ago, air generally contains far too many nuclei for rain-formation. It is only when the nuclei are relatively few that the drops forming on them can grow to raindrop size. Again, an Australian experimenter of considerable scientific ability has used kites and captive balloons for altering the electrical state of the atmosphere at high levels, and claims to have produced appreciable rainfall in this way. But alas! all experience shows that there is nothing so fallible as human observation, and that the zealous observer nearly always finds the results he is looking for. Army officers who watched and took part in the recent experiments at McCook Field are quoted as having seen the clouds cut to pieces and dissolved as if by magic under the sand-bath treatment. Their reports are impressive, and may be free from unconscious exaggeration and self-delusion; but we should like to reserve judgment.

We are unable to see any reason why, even if the airplane, with its discharge of electrified sand, should start an active coalescence of cloud particles along its path; this process should extend very far, either vertically or horizontally. A momentary fall of rain through a thick cloud surely will not dispel the latter throughout its vertical extent. The grains of sand would quickly lose their electrical charge through combination with oppositely charged cloud particles, and thereafter would behave the same as any other mineral dust found in the atmosphere. The occurrence of large quantities of dust in the atmosphere is a common enough phenomenon, but not one that is conducive either to dispelling clouds or causing rain. In extreme cases, as after desert sand-storms, volcanic eruptions or forest fires, the dust or soot in the air merely renders the ordinary clouds far more dense and opaque than usual, sometimes to such a degree as to turn day into night. Last but not least, the dust blown up from the ground in desert storms is always highly electrified, as was shown ten years ago by Prof. W. A. Douglas Rudge.

The best judgment hitherto pronounced on weather-making experiments in general was that of Sir Napier Shaw, late director of the British Meteorological Office, who said:

"Within our knowledge we are lords of every single specimen of the atmosphere which we can bottle up and imprison in our laboratories, our furnace flues and our greenhouses; but in the open air the ordinary inexorable laws which control the behavior of the atmosphere when we are awake and when we are asleep, have such enormous masses of energy in the form of warmth and water vapor in reserve that our own little reserves are not equal to making any serious impression on the course of nature." He added, however: "Many opinions of the futility of human efforts have been proved to be wrong; all awkward corners may be turned by new inventions." It ought not to be difficult to prove beyond the peradventure of a doubt whether or not Messrs. Bancroft and Warren have turned such a corner; and we await with interest the results of properly controlled scientific investigations.



**W**HILE the revolving stage idea is by no means new, having been applied in practice both here and abroad, the latest version has many points of novelty. For one thing, the revolving stage just completed for the Grand-Theatre of Lyons, France, is of the most ambitious proportions, as may be gathered from the accompanying full-page drawing. Then, too, this huge revolving stage is more than a mere revolving platform; the grill overhead, which carries the hanging scenery and the fly galleries, revolves with the platform so that a scene can be made up on the rear half of the revolving stage while the front half is being occupied by the actors in full view of the audience.

The present revolving stage was conceived back in 1905 by M. Gustave Garnier of Lyons, but it was not until 1921 that the construction of this stage was decided upon by the municipal authorities of Lyons, the theater being owned by the municipality.

The revolving stage design as worked out in this case has many advantages over the usual stationary stage. To begin with, of course, it offers a means of shifting from one scene to another with great rapidity. The playwright no longer is limited to a small number of scenes, as heretofore. Then, too, the revolving platform is provided with an arrangement of slots so as to

## A New Version of the Revolving Stage Idea

hold scenery in position, as depicted in our drawing. The usual hanging scenery is suspended by cables from the grill above, where a battery of motor-operated winches raises or lowers the desired scenery. This arrangement of the scenery is said to make for less congestion than the usual stage installation, and to reduce the fire risk materially, especially in view of the steel construction employed. Since the platform and the grill revolve together, the rear half of the stage can be completely set by the stage hands and, in a minimum of time, revolved into position.

The mechanical details of the French revolving stage are plainly indicated in our drawing. The structure is virtually a cylinder, divided into two parts by the back scenery or horizontal. However, if desired, the horizontal may be moved forward or backward to decrease or increase the depth of a scene, since the horizontal is suspended from a trolley arrangement. The entire cylinder-like structure revolves about its center axis, the driving power being supplied by an electric motor through a common vertical shaft and simple chain transmission. Rollers are provided at the top and the bottom to facilitate the ready turning of the stage.

The small insert in the lower left-hand corner of our

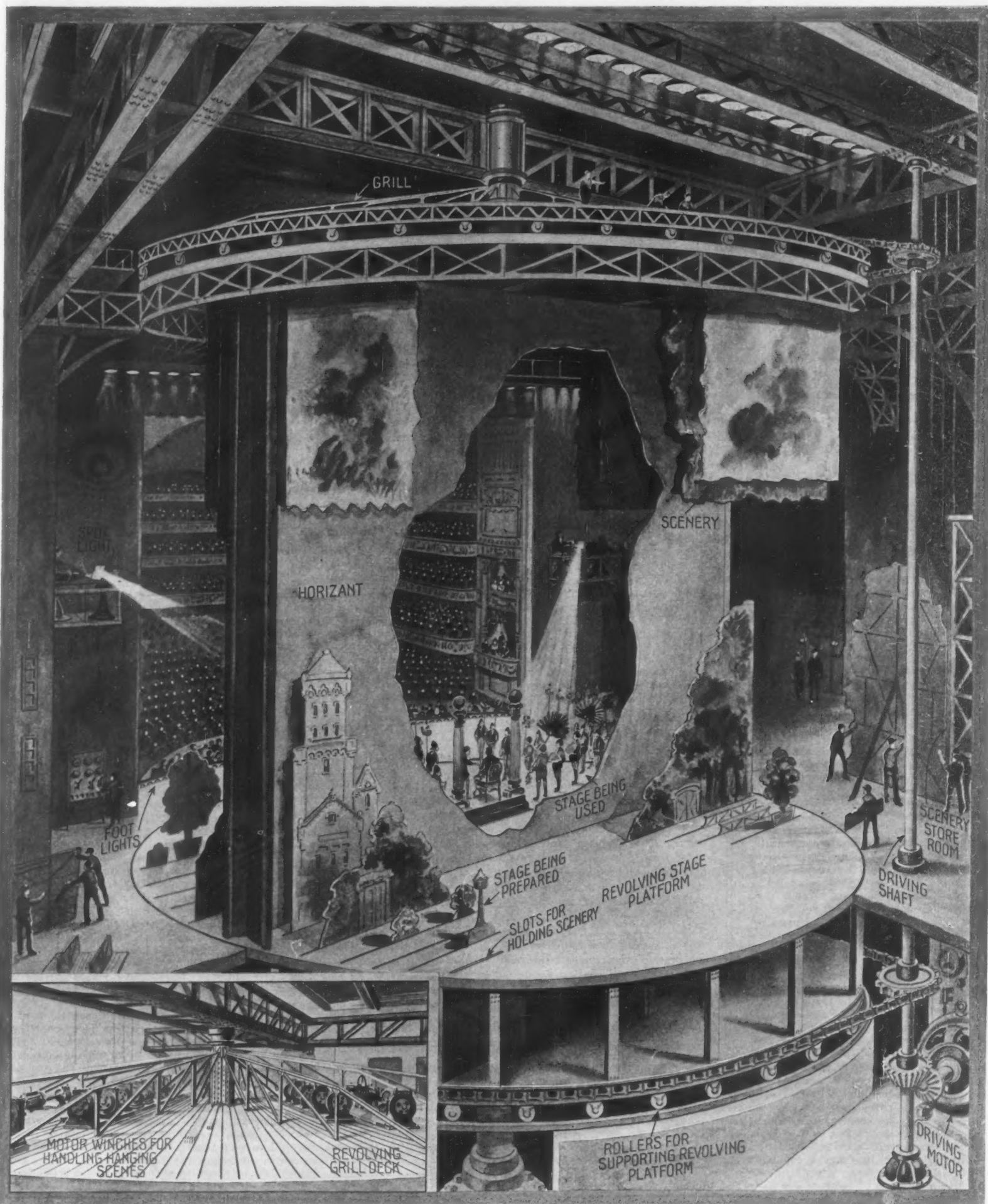
drawing shows the platform on top of the grill. Here are to be found two 13-horsepower electric motors, one for each scene, for

handling the hanging scenery. These motors drive shafting and simple clutch mechanisms for operating the winches connected with the various sceneries. This installation is said to facilitate the handling of scenery; in fact, any scenery can be raised or lowered at will, and even all the sceneries can be handled at one time because of the ample power of the motors. Meanwhile the standing sceneries are held in place by a system of slots which are indicated in our drawing.

The grill also carries ten suspended balconies or fly galleries, which are reached by means of ladders from the grill platform above. These balconies serve for the control of scenery manipulations and for the handling of spot lights. There are also suspended from the grill and between the fly galleries certain monorail arrangements on which operate electric cranes for the lifting of heavy objects. These electric cranes can run clear across the entire width of either half of the revolving stage.

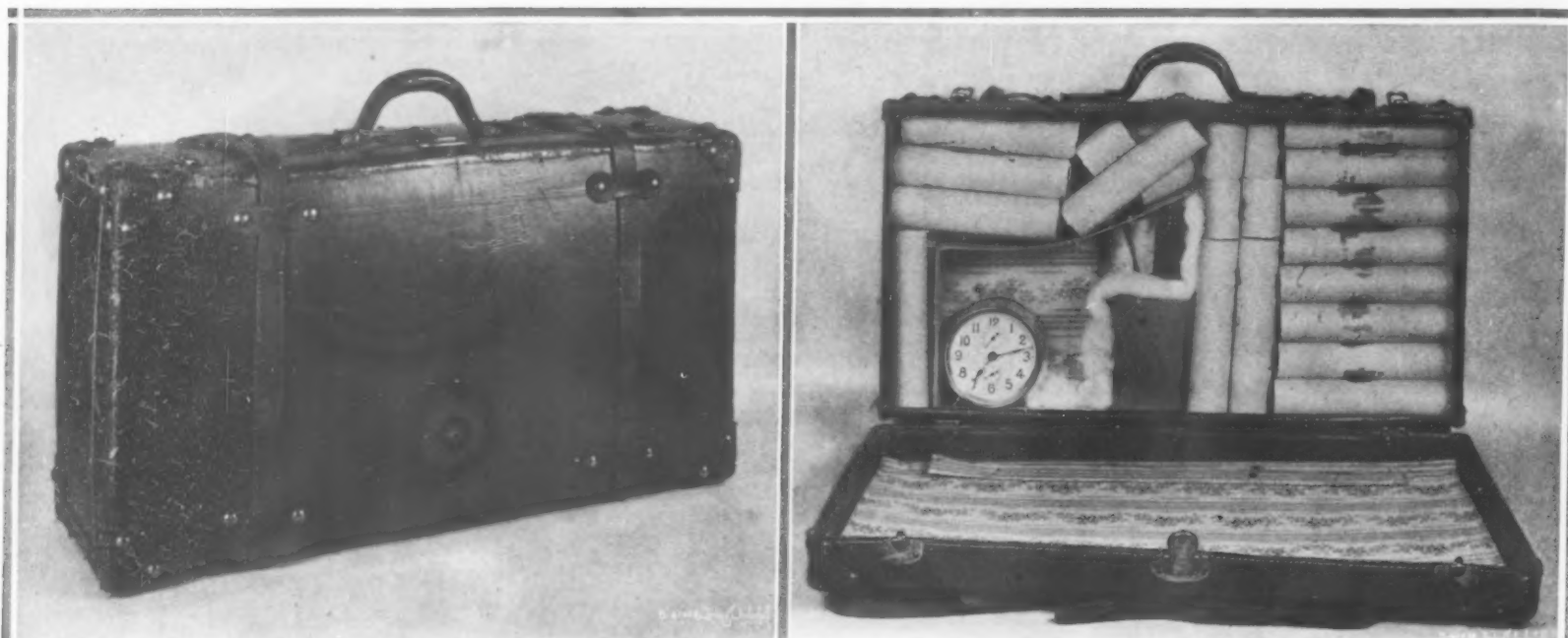
This revolving stage idea is decidedly different from the six-stages-in-one idea shown in our March issue. The latter also had for its object the rapid change from one scene to the next, but on a very much smaller scale.





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THE LATEST VERSION OF THE REVOLVING STAGE IDEA AS CARRIED OUT IN THE GRAND-THEATRE OF LYONS, FRANCE  
(See facing page for article)



In staging these pictures, papier maché rolls were used in lieu of dynamite; an ordinary alarm clock was used for the timing device without any perversion of truth, and a chemical tippie served as the trigger. The connections between these units are purposely omitted, and the percussion point is also masked from view, to avoid the giving of actual working instructions for bomb construction

Inside and outside appearance of a bomb similar to the one that wrecked the Los Angeles Times building

## Bombs and Bomb Plots

### Something of the History and Construction of the Terrorist's Favorite Weapon

By Roy A. Giles

**I**N SICILY, where God writes poems in cloud fleece on the pale blue background of a perfect sky and where the sun sets in a splash of colors radiant beyond description, the children are taught a crude science of high explosives, almost before they are taught their prayers. Thus we arrive at one of the main sources of bombs and bomb plots.

It is not that the Sicilians manufacture or plant all the bombs. There are bomb-makers and anarchist types and organizations in all nationalities, but the very nature of Sicilian life makes the criminal anarchist from this island a particularly dangerous and active destructionist. Sicilian bomb-makers are known to have offered their services for hire to anarchists of various nationalities. But to do them justice they had no part in the making of the deadly infernal machines used by the criminal element among the structural iron workers' union in this country or among a Spanish group convicted of sending out bombs wholesale, through the mails.

In Sicily, saints days and other festivities are celebrated by the firing of bombs, just as Independence Day used to be celebrated in this country by the exploding of fireworks. Just why the Sicilian believes the saints should be pleased with so much noise and accompanying danger is something that is left for the Sicilian to explain. But the truth remains that Sicilian children are taught a simple chemical combination that is highly explosive. They are taught to encase this explosive in a paper core and by repeated wrapping and dipping in shellac and a repeated drying process they produce bombs which are not only noisy but also are highly explosive. A dangerous bomb of this type is shown in one of the accompanying pictures. These bombs have been used in many lesser plots to extort money, and in vendettas. Forty-nine of them were bought and used by one group of American gamblers in Chicago to annoy and harass another gambling group.

Forty-nine different premises were wrecked in this gamblers' war, without an arrest being made by the police. Finally the gamblers settled matters among themselves and the bombing ceased. Labor wars in Chicago have caused many explosions of this type of

bombs and recent arrests of a criminal labor group brought to light a factory with an expert bomb-maker in charge.

It is quite a jump from sunny Sicily to the sidewalk in front of J. P. Morgan & Company's banking establishment at Wall and Broad Streets, New York, where thirty-three people lost their lives and more than a hundred were injured by the explosion of the most devilish portable infernal machine ever devised by a human brain. There is no evidence that the Wall Street

crime detection as it is in plotting the specifications for a subway or the mathematics incident to an astronomical observation. While the science of the detective is growing more perfect, the science of the criminal has ever been crude. Among the ingenious works of the criminal there are few of the nice measurements or distinctions one finds in the perfecting of a range-finder or in a spectroscopic observation; yet the crime engine is very effective, as the ripped and gutted bank safe and the wrecked and bloody Wall Street corner have shown.

Before attempting to reconstruct the exploded bombs shown in the illustrations, I worked back over the trail of bomb plots, with which I have charged my memory, and from the debris and effects of the explosions, to the completely reconstructed bombs. When I suggested these reconstructions, which necessarily must be more or less crude, I got a quick audience with the editors. But I realized that such an enterprise might cause me to be well arrested, "collared" or "pinched," as the crooks say. So I had to go and give myself up to Lieutenant Gegan, bomb expert of the New York Police Department, and to C. J. Robb, superintendent of the New York office of a well-known detective agency.

I explained to Lieutenant Gegan that in order to interest scientists in the gory and sordid researches of criminology I had found it necessary to shoot my camera at the mechanical and mathematical aspects of crime. Neither Lieutenant Gegan nor Superintendent Robb thought well of the plan until I promised that the actual

connections between the time devices and the explosives would be left out of the pictures.

To my mind every indication is that the explosive used in the Wall Street bomb—the first portable infernal machine ever constructed in the bed of a wagon—was explosive gelatine. In the bomb, as it was hauled into Wall Street, by an ill-fated horse, the actual explosive cartridge was camouflaged by an ordinary barrel, bits of which were found in the debris. Enough fragments of tinplate were also found to warrant the assumption that two 5-gallon cans of some highly inflammable fluid were in the wagon.

The picture will show the construction based on other dissected bombs and a reasonable knowledge of bomb

**W**HEN we asked Mr. Giles to ornament his bomb article with some bomb photographs, he made the very plausible objection that a bomb comes to the attention of the police only through its explosion, or through its detection before explosion; that in the former case the bomb is obviously destroyed and in the latter case the treatment which it receives in order to insure the safety of those opening it is calculated to destroy its structure and that a photograph of a real, live bomb was therefore out of the question. So we decided upon the next best thing; and while on general principles our policy is entirely against staged photographs or faked-up settings, we felt that staged photographs were in this instance to be preferred to none at all. So Mr. Giles and Lieut. Gegan of the New York Police, together with Mr. C. J. Robb of the Burns Detective Agency, put their heads and their knowledge of bombs together and evolved the replicas of famous bombs which we show on these pages. Incidentally, they had to consult on what to leave out as well as on what to put in, since neither we nor they have any desire to conduct a course in the technical details of bomb-making for the benefit of everybody who may have access to this issue of our journal.—THE EDITOR.

bomb was of transplanted Sicilian manufacture. There is no idea of accusing any nationality. The point is, simply, that it is well not to entrust information concerning high explosives to children and that the United States made a long step forward in civilization when it inaugurated the "Sane Fourth of July."

There is a trail that wriggles snakelike through bomb-plot wreckage extending from the Los Angeles Times Building on the Pacific Coast, where twenty-one lives were sacrificed, to the banking house of the Morgans in Wall Street and the home of Judge John C. Nott in East 61st Street, New York City. This trail, to my mind, is as definite as logic and science can make it. I believe that science is almost as necessary in



craft. The assumption that this Wall Street bomb was battery-fired and that a double flame-train led from the batteries back over the two cans of inflammable fluid to the point of percussion is mine. It is possible that the trigger was a mechanical tippie equipped with a bottle of acid, as was the case in the Los Angeles Times bomb.

Any mechanical scientist can follow the train without my going into details here which might cause some weak-minded person to start bombing on his own. The points of percussion are left veiled in both reconstructions for the same reasons.

It is possible that the explosive in the Wall Street bomb was dynamite instead of explosive gelatine, but I do not think so, judging from the color of the smoke described by witnesses. Gelatine is available to any good thief, and the explosives in these cases are usually stolen.

The reproduction of the Los Angeles Times bomb I believe to be reasonably exact, with the purposely omitted connection between the time device and the tippie, which was also omitted purposely. The time device in this bomb was an ordinary alarm clock. In this case I had the reports of detectives, who traced purchases and thefts made prior to the manufacture of the bomb, to aid me in my deductions.

There were half a hundred of these portable suit-case bombs charged to have been used by the criminal element within the Structural Iron Workers' Union, some of whom were convicted. The bomb planters in this group carried these bombs about on trains to the peril of our women and children, handling these instruments of wholesale destruction and death generally as carelessly as some policemen handle their facts. The bombs were used to blow up bridges and other structures which were non-union made and which met with the disfavor of misguided industrial agitators.

The utter foolhardiness of the anarchistic bomb planter can be realized when it is summed up that the victims in every bomb plot have been poor people, whom the most rabid anarchist could not reasonably envy or object to. I know of no big bomb plot where the person for whom the bomb was really intended was ever injured by the bomb.

Reasoning into the known details of the various bomb plots in the United States, which are a small part of the bomb plots recorded in the world, I have found a connecting train as definite as the flame-train which leads in an infernal machine from the time device to the point of percussion.

For instance we find that an attorney or judge who has aided in the prosecution of a suspected bomber or agitator in one case is the recipient of a bomb in the next plot to follow. There is either excellent organization, or else an uncanny telepathy and understanding, existing among these criminals, leads one bomb plot directly into another.

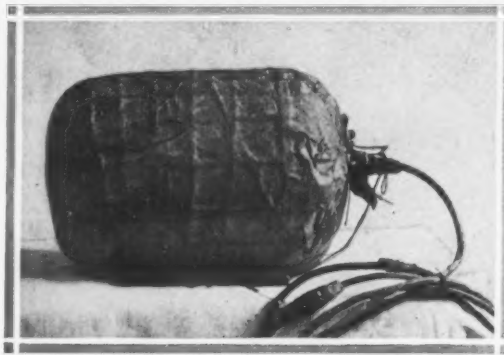
Speaking of telepathy, it has played a peculiar part in the recorded data concerning bomb plots. It is an established fact that Mrs. Nott, wife of the jurist, whose home was wrecked by a bomb explosion which cost two lives, had telepathic knowledge several days in advance that the bomb was to be planted, but unfortunately she did not know where or when. Fisher, the tennis player, who, by some telepathic means, predicted the Wall Street explosion a month in advance, was convicted of insanity; yet we go on using our mechanical radios unmolested.

In all forms of crime it would appear to the average mind that it is more constructive to reform a criminal than to execute him. This also has a humanitarian appeal. Among criminal anarchists, however, the statistics appear to be against processes of attempted reform. There are two contrasting cases in point. Tannenbaum, the American agitator convicted of criminal anarchy, reformed after serving his sentence, worked his way through college, and became a very useful member of society. Vito Mariano, arrested with bomb plotters in New York, was deported to Italy, and continued his wild career. He was convicted of being the chief plotter, if not the actual planter, of the Milan Opera House bomb, which cost 39 lives. Italy has the idea of reform rather than execution and Mariano was sentenced to life imprisonment. The United States seems to have lost this resident in the nick of time.

The figures reveal that, once a type of infernal machine is devised, it will continue to crop up, even though the inventor is dead or in jail. Twenty years ago an ingenious type of bomb was sent through the mails to

David H. Moffat, millionaire banker and railroad builder in Denver, by a youth who hoped to warn Moffat in time and thus win favor with the millionaire. The bomb failed, the scheme to ingratiate failed, and the youth, just 18 years of age, was given a few years in the Canon City Penitentiary to think it over.

This bomb was of a type so original in its construction that no one would believe that any two men would hit upon the same method of explosion. Yet just a few weeks ago, exactly the same type of bomb was delivered by a messenger to Jacob Purcell, a furniture dealer in the middle west side of New York City. Two months previously the New York bomb squad found another of this type of bomb. These three instances are the only ones where this type of bomb has been

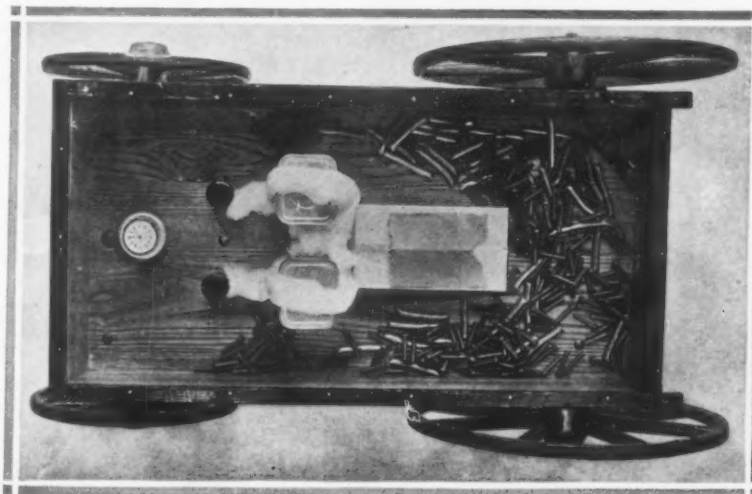


Crude type of Sicilian high-explosive bomb, capable of considerable destruction. It is manufactured by repeated wrapping and dipping in shellac

used in this country, at least over a period of 20 years.

Hand-grenade bombs have been used more frequently in Europe than in America. In this country, if my memory serves me right, I know of no case of a hand grenade being thrown since the Haymarket riots in Chicago some 35 years ago, when bombs tossed in a Socialist street meeting killed nine policemen and others. This bloody Haymarket riot inaugurated the bomb plots in this country and they have continued at intervals ever since. Anarchist groups in this country are located, classified and watched ceaselessly, and yet bomb plots recur with unceasing regularity, and there is nothing just like a bomb to destroy its own evidence.

The motives are usually jealousy, envy and greed on



This affair was a gelatine bomb, of such size as probably to fill fairly well the rickety wagon on which it was brought to the point of discharge. This miniature was made up on the assumption that the original was battery-fired

#### Reconstruction of the Wall Street bomb that killed 33 persons

the part of plotters who would rather plot destructively than to work constructively with less effort and greater financial return. Extortion and revenge play their part occasionally and these unlovely human emotions mixed with high explosives and quick flames of human hate and chemical combustion blast constructive endeavor and make more remote the dawn of the universal brotherhood of man for which the average Socialist claims to be striving.

#### An American Anthropoid Primate

AT the recent meeting of the National Academy of Sciences in Washington, Dr. Henry Fairfield Osborn announced the discovery of a tooth giving evidence of a pre-historic and unknown species of anthro-

poid intermediate between the ape and the earliest man. This discovery was made by Harold J. Cook, of Agate, Neb., in the middle Pliocene formations of that State. Worn by use when its owner was alive, and worn by water in the centuries since, this tooth matches no known tooth of ape or man, modern or extinct. It is very different from the tooth of the gorilla, the gibbon or the orang. It is nearest to that of the chimpanzee, but the resemblance is still remote. Nor does it resemble very closely any human molar, although it is nearer to the human than to the ape type of tooth. Consequently Dr. Osborn classifies it as a new species and genus and names it *Hesperopithecus haroldcookii*, which being translated backward from the biologist's Latin means "the anthropoid from the west discovered by Harold Cook." The fossil was found in the upper phase of the Snake River beds, associated with remains of the rhinoceros, camel, Asiatic antelope and an early form of the horse, now extinct.

The remarkable feature of the discovery lies in the fact that hitherto no specimen of anthropoid primates, ancient or modern, have been discovered in America, although they are common in the Old World. It is possible that this Nebraska tooth will open a new chapter in geological history which may throw light on the vexed question of the origin of man.

According to Dr. Osborn, the animal is a new genus of anthropoid, probably one which wandered over here from Asia with the large south Asiatic element which has recently been discovered in our fauna by Drs. Merriam, Gidley and others.

#### The Detection of Cultivated Japanese Pearls

THE pearl, perhaps of all jewels, offers the most difficulty in the detection between the artificial and natural product. A well-made artificial pearl cannot be told from the natural pearl by mere observation, that is, without the aid of certain tests, such as rubbing over the teeth and between the fingers. The artificial pearl appears smooth to the sensitive enamel of the teeth, and heats up when rubbed between the fingers, becoming slightly sticky, while the natural pearl gives a rough sensation and does not heat up and become sticky. While these are infallible tests in detecting the strictly artificial pearl from the natural or Oriental pearl, when it comes to telling the difference between the natural pearl and the pseudo-natural or Japanese cultured pearl, it is entirely another matter—a task which has been practically impossible up to the present time without destroying the pearl in the course of the test. And obviously, this is not always feasible.

As is known, the Japanese artificially cultured pearl is grown exclusively in Japan. The oyster is caught, the shell is pried apart and a nucleus in the form of a sphere of mother-of-pearl or other suitable material is introduced. In this way the physiological process within the oyster, which results in the secretion of a juice, the coagulation of which around the extraneous particle produces the pearl, is stimulated and the result is a comparatively large pearl, the Japanese cultured pearl. The size of the internal nucleus with respect to the size of the whole pearl varies, and often it forms by far the greater part of the pearl. Such a gem is by no means the equal of the real natural product and should not command the same price.

But the jeweler has been at a loss to tell the difference between the two types of pearls. He could distinguish between natural pearls from different countries, Japan, Australia, Ceylon, etc., by little variations in the color and sheen, but it has not been possible for him to distinguish between the natural and cultured pearl without destroying the gem by cutting it in half. Such a method of testing

is very wasteful, to say the least.

However, recent developments have shown that it is possible to test pearl in a simple, easy and effective manner, avoiding any destruction or even slightest impairment of the quality of the pearl. For this purpose, the common mercury vapor arc light, the ultra-violet light, which is used for therapeutic purposes, is employed. The difference between the two types of pearls is manifested so clearly under this light that even the layman, having no experience at all with pearls, can tell the difference. The Japanese pearl shows a distinct translucent opalescence under the light while the natural pearl, though opalescent, is opaque under the same conditions.—C. S. Fox, *The Chemical News*, Aug. 11, 1922.

# Our Point of View

## The Economics of Bigness

**I**N YEARS gone by visitors who came to observe the United States, its people and its ways, made the criticism that we were prone to exaggeration and to the worship of mere size, as such. Whatever of truth there may have been in this at the time when Dickens wrote his American Notes, neither offence can be laid to our account today. The statements of a man who is much given to exaggeration are discounted by that much; and if we are continually building the longest, widest, deepest, loftiest, heaviest structures on earth, it is not from any worship of bigness as such, but rather for the very good reason that great size and economy are apt to go hand in hand. The same law holds good in all financial and industrial activities.

The reaping machine of the West, cutting its 25-foot swath; the 350-ton locomotive hauling its 7000-ton coal train; the 1000-foot steamship; the towering office building, housing a whole townfull of people; the individual 70,000-horsepower water turbine; the 100,000-horsepower steam turbine; and all those mechanical and industrial giants which have sprung up in the last twenty-five years, have grown to their present dimensions in obedience to the well-ascertained fact, that there is economy in concentration, and that, within reasonable limits, the bigger the individual unit the cheaper will be its productive output.

This thought has been suggested by a recent study of the rapid growth in size of the hydraulic turbines which are being built for the various large hydro-electric plants in the country. Let us enumerate a few of these. Starting in California we note that the Pacific Gas and Electric Company are having built two 40,000-horsepower, vertical-shaft, reaction turbines; and that the Skagit Development Company's plant of Seattle, Washington, also includes two water turbines of equal size. Then there are being installed three 35,000-horsepower, vertical-shaft Francis units for the Southern California Edison Company. Crossing the continent to that great center of hydro-electric development, Niagara Falls, our readers will remember that the hydro-electric power commission of Ontario is building a huge plant at Queenston for the development ultimately of 600,000 horsepower. Here, under a head of 315 feet, the power of Niagara River will be developed in five enormous 55,000-horsepower machines. This is a Canadian enterprise. Crossing the river to the American side, we find that the greatest turbine of all will be represented by three 70,000-horsepower, vertical-shaft, reaction turbines, which are being installed by the Niagara Falls Power Company in what is known as hydraulic plant Number Three. At this rate of increase we may look before very long for a water turbine which, in output, will equal the 100,000-horsepower steam turbine at the 77th Street subway power station in this city.

In the SCIENTIFIC AMERICAN of July 22, 1899, will be found an article on the then newly-installed turbines of the Niagara Falls Power Company mentioned above. They were the wonder of their day, for each turbine was capable of developing no less than 5000 horsepower! It is a far cry from 5000 to 70,000 horsepower; but the increase is justified by a strict consideration of the economics of hydro-electric power production.

## The Death Toll at the Mines

**I**T IS high time that the technical and the daily press of the country raised an outcry against the frightful slaughter which takes place annually in the mining industry. Such agitation, intelligently and persistently carried out, will lead to the kind of governmental action which has shown such good results in cutting down the statistics of railway accidents.

The SCIENTIFIC AMERICAN was one of the first, if not the first journal, systematically to draw to the attention of the public the large and wholly unnecessary loss of

life due to faulty equipment and careless operation of our railroads. Twenty to twenty-five years ago our railway accident list was a national disgrace. Today, thanks to the cooperation of the Interstate Commerce Commission and the railroads, railroad travel in the United States, in respect to safety, compares favorably with that of other countries.

But in this matter of loss of life in the mines, we have much to do in the way of accident prevention. How many of us know that miners are being killed in this country at the rate of 2400 a year, and that the total deaths for the past ten years amount to 23,979. Last September 47 died in a California coal mine; in the following November 77 were killed in a Pennsylvania coal mine, and a few days thereafter 84 perished in a coal mine in Alabama. This shocking record has reached the very heights of tragedy in an explosion in New Mexico in which the lives of 120 miners were snuffed out.

It took some time to establish the fact that the majority of the railroad accidents was due to carelessness, lack of discipline, and positive disregard of orders on the part of the railroad employees; and it is quite possible that a searching analysis of all the mining accidents would reveal a corresponding carelessness and disregard of safety regulations among the miners. If so, a great reduction in the toll of life can be secured by an earnest "Safety First" campaign. At the same time, a thorough search should be made for safety appliances that will throw around the miner such additional material safeguards as resulted from the introduction of the original Davy miners' lamp.

## Belittling the Washington Treaty

**T**HE Washington Treaty for the Limitation of Naval Armaments was acclaimed by the unanimous voice of the American people as one of the greatest works of constructive statesmanship in the history of this Republic. Such was the good faith of the United States, Great Britain and Japan, that they set about the reduction of their fleets before the treaty had been signed by the five powers concerned. Thus, the United States immediately ceased construction on eleven 43,000-ton battleships and battle cruisers; Japan did the same on her new capital ships; Great Britain cancelled contracts for four 47,000-ton ships, and scrapped or disabled, and sold out of her navy eighteen of the dreadnoughts that fought in the Battle of Jutland.

In spite of these magnificent results, there is a small but extremely active minority, which, for reasons of its own, is deeply chagrined over the success of President Harding's great move to consolidate the peace of the world. Its habitat is Washington, and its mouthpiece is a band of self-elected naval experts, who for twelve months past have done everything they could to spread upon the pages of the daily press whole columns of misrepresentation, tending to show that the treaty is a failure and that none of the signers of the treaty except the United States, is doing anything to reduce its navy.

Now this deliberate and malicious misrepresentation is beginning to have its repercussion (as it was certain to do) upon the other side of the water; for we note that Mr. Archibald Hurd, a well known British naval critic, has written an article in *The Fortnightly Review*, under the title "Is the Washington Naval Treaty Doomed?" which shows that he has taken this anti-treaty propaganda at its face value, and believes that it is representative of American public opinion.

So much is he worked up over the matter that he appears to have lost his bearings altogether, as may be judged from his amazing statement, that the Naval Conference aimed at a 5-5-3 ratio in capital ships only and *not in lighter, unarmored craft*. That nothing could be further from the truth is shown by the following extract from the speech in which Mr. Balfour accepted the principle of the American proposals: "Taking these two, the battleships themselves and the

vessels auxiliary and necessary to a battle fleet, we think the proposition between the various countries is acceptable."

Again Secretary Hughes at the close of his opening speech said: "The plan includes provision for the limitation of auxiliary craft . . . such as auxiliary surface craft, submarines and airplane carriers." In agreement with this purpose the allotment was for the United States and Great Britain, each 450,000 tons, and for Japan 270,000 tons. The absurdity of Mr. Hurd's contention will be evident.

So far from being a failure the Treaty has been a brilliant success. Italy has recently added her signature; France will follow, and the wholesale breaking up of ships, in which Mr. Hurd's country has shown the way, will thereupon be carried out by every nation concerned.

## Concrete Road Problem

**T**HE ideal concrete road would be one of uniform strength and wearing qualities over its whole surface; but experience has shown that where the concrete slab is of uniform thickness, there is a tendency for the outer edges, when subjected to the maximum loading, to fracture and break down. The Illinois Division of Highways has been carrying out a series of trials on what is known as the Bates Test Road, near Springfield, Illinois, in which a concrete slab, designed to obviate this weakness along the edge of the slab, has been tested under the maximum loads allowable under the laws of the State.

The tests proved conclusively that a slab of uniform thickness throughout is weaker at the edges than elsewhere. This weakness is inherent in a slab of uniform section, for the reason that a square foot at the edge, unlike a square foot within the body of the slab, receives support from the adjoining material on three sides only. To remedy this the new slab is thickened along its outer edges, and the center thickness is reduced. Thus, the new cross section is nine inches thick at the extreme edges of the slab, and tapers to a thickness of six inches at a distance of two feet from the edges. Elsewhere the thickness is uniformly six inches. It is interesting to note that the new slab has a cross sectional area one square foot less than a slab of a uniform thickness of seven inches. Translated into yardage this means that each mile of pavement, built on the new system, will require nearly 200 cubic yards less of concrete. The State of Illinois is so well satisfied with the result of the test that the new type of road has been adopted as standard, and all of the recent road bids require that it shall be used.

We are making rapid strides in the development of a durable concrete road. It is not so very long ago that the breaking down of concrete highways was so rapid that the question of the suitability of this material for heavy motor traffic was debatable. Today the problem is so well in hand that, with rigidly enforced regulations as to maximum allowable wheel-loads, we may expect that the concrete road of the future will be as durable and more satisfactory than any of its competitors.

## The Nicaragua Canal Problem

**P**RESIDENT HARDING and Secretary Weeks of the War Department recently announced that, because of the rapid increase of Panama Canal traffic during the past six months, the matter of building another canal at Nicaragua should be given serious consideration. Immediately thereafter, and following a report by Major Beach, Chief Engineer of the Army, that today, because of the high cost of labor, machinery and supplies, a canal at Nicaragua would cost \$1,000,000,000, there followed an announcement by President Harding that the project had been abandoned for the present.

To those of us who are conversant with the enormous capacity of the Panama Canal, it is evident that this sudden and very emphatic forcing of Isthmian canal



# Our Point of View

matters into the forefront of public affairs was prompted not so much by technical as by political considerations. The Panama Canal has lately been carrying only from one-fourth to one-third of its maximum capacity; and it was well understood in engineering circles before Major-General Beach made his report, that the building of a canal at Nicaragua would cost between two and three times as much as the Panama Canal.

Therefore, the public will be justified in the belief that this sudden resuscitation of the Nicaraguan project, which, so far as the public is concerned, has been dead and buried for nearly twenty years, was a diplomatic way of announcing to the world at large that the United States had preempted any possible additional canal route from the Atlantic to the Pacific, and that when the time came for the construction of a second canal it would be the task of the Federal Government to build it.

At the same time it is gratifying to remember that the ostensible motive for bringing up the Nicaragua question was the very remarkable rate at which traffic through the Panama Canal is growing. During the past six months the traffic has increased at the rate of over 50 per cent. There was an increase in the number of ships passed through of from 240 to 425, and an increase in the tonnage carried of from 1,099,450 to 2,447,897. Gratifying as these totals are, we must bear in mind that they represent only a fraction of the total carrying capacity. This question was discussed in our issue of February last, when we drew attention to the fact that the canal could accommodate four times the volume of traffic it was carrying up to the end of last year.

With the construction of an additional dam for the storage of water further up the Chagres River, and by the construction of an additional flight of locks adjoining the existing locks, it will be possible when the time comes to add another 50 per cent to the present maximum capacity of 50,000,000,000 tons per year. That would mean a total capacity of about 75,000,000,000. If we compare this total with the tonnage of cargo passed through the canal in 1922, of 13,710,556 tons, it is evident that there will be no call for the construction of a second canal for some decades to come.

Admitting all these facts, we must not forget that it would take many years to build a canal at Nicaragua. Therefore, it would be prudent for the government to make the necessary preparations, decide upon the dimensions of the canal prism and of its locks, and prepare the plans and specifications; so that when in future years there comes, as there surely will come, a demand for a second canal, the work can be put in hand at once and pushed through with all possible dispatch.

## How Everyone Can Help the Patent Office

**I**N PREVIOUS issues of the SCIENTIFIC AMERICAN we have discussed at some length the unsatisfactory conditions in the Patent Office, particularly as regards the absurdly inadequate salary of the Primary Examiners. Until February 18, 1922, when the Lampert Patent Office bill was enacted, the salary of a Patent Office examiner was only \$2,750. The Lampert bill raised this to \$3,900 a year, and, although this was the largest proportionate increase that had ever been obtained through any bill in Congress, it was still woefully inadequate to attract properly qualified experts as examiners. The position of a primary examiner is one of the greatest importance to the public interest. If a sufficient salary be granted, and only then, will it be possible to attract to the service men of adequate personality and possessed of those scientific and legal qualifications which are necessary to make sure patents will be granted wherever the inventions warrant it. It takes a man of broad technical training and sound judgment to detect those cases where the distinctions between the alleged invention and the prior art are not really prac-

tical commercial distinctions but are mere paper differences. An examiner with such qualifications will be a sure safeguard against granting patents which can result only in useless and expensive litigation, not only to the patentee but to the innocent defendant, and cause a waste of time in the courts of the government itself. It is believed that a salary of \$5,000 for a primary examiner would attract a sufficient number of high-class men of the type described to fill that position.

The Lampert bill stopped for the time being the rapid break up of the Patent Office. This disorganization was due to the fact that the primary examiners were leaving the Patent Office and taking positions where they could get a salary commensurate with their ability. But it should be well understood that while that law temporarily arrested the debacle, it by no means entirely got rid of it; for in these days of high cost of living it is certain that a salary of \$3,900 is not sufficient inducement for a high-class man to give his services permanently to the Patent Office, and look upon the position as a life job.

Now, there is before the Senate today the Sterling-Lehlbach reclassification bill, H. R. 8928, which has passed the House by a large majority, although in so passing the salary of primary examiner was reduced from \$5,040 to \$4,600. The Civil Service Committee of the Senate has reported a bill recommending a restoration to \$5,040. The Sterling-Lehlbach bill has been approved by such influential organizations as the New York Patent Law Association, the Federated Engineering Societies (the professional and scientific schedule), the National Civil Service Reform League, and others. The engineers, chemists, scientists, and manufacturers proved with the Lampert bill of last year that they could induce Congress to pass a just and wise measure in the face of intense opposition. There is no such opposition to the present bill, and in urging our readers to write to their representatives in Congress in its favor, we would remind them that the enactment of this bill would not only secure permanently a high grade of Patent Office examiners, but it would raise the standard of all professional service in the various departments of government. Prompt action must be taken as the Congressional session ends March 4.

## Diesel Engines for Naval Vessels

**A**T A recent meeting of the Institution of Engineers and Shipbuilders, in Scotland, there was an interesting paper on the possibility of using the Diesel engine as a drive for warships of large power. The author of the paper, Lieutenant-Commander Mesurier, R. N., gave some facts as to a new motor-driven passenger liner, with engines of 13,000 brake horsepower, which is being built by the Fairfield Company. The development of the propulsive power on four shafts made it possible to keep the individual engines within moderate limits, and since all the fundamental problems have been solved, the builders have no doubt of the success of the ship.

The author of the paper, taking the engines of the new passenger liner as a basis, presented a study of the maximum power per unit that might be obtained in a warship, without taking undue risks, by making use of the single-acting, two-cycle, Sulzer type of engine. It was shown that a naval vessel, developing 40,000 brake horsepower on four shafts, would require four main engines with eight cylinders per engine, and a brake horsepower of 10,000. Electrically driven turbo-blowers and cooling-water pumps would absorb 700 horsepower for each main engine, and the total weight of the main and auxiliary engines, the blowers, pumps, compressors, etc., would be about 2750 tons, or some 150 pounds per horsepower, as compared with 70 pounds for submarines and 290 pounds per horsepower for ordinary cargo vessels, fitted with the same type of engines.

The main advantages, from a naval standpoint, would be an increased radius of action on a given

supply of fuel; the ability to proceed to sea at short notice and to jump rapidly from cruising to full speed; the absence of uptakes and funnels, thereby allowing the armament to be disposed for the best military effect; the decreased danger from aircraft attack, because of the reduction of the openings in the armored deck; and the elimination of the risk of damage due to the fracture of steam pipes, or the penetration of boilers. Finally, the absence of smokestacks would provide a perfectly free landing deck throughout the whole length of the ship.

## A Great Work Quietly Done

**A**S WE go to press, announcement is made that, after five years of constant work, the engineers of the Shandaken Tunnel have broken through the last remaining rock, and have met in the center of the range of the Catskill Mountains, which divides the watershed of Schoharie Creek from that of the Esopus.

To anyone with imagination there is something dramatic in what these engineers of the Board of Water Supply of New York City are doing. Esopus Creek, which has already been impounded, flows to the Hudson down one of the valleys of the Catskill Range. Schoharie Creek, which heads on the opposite side of a lofty mountain, flows to the Mohawk River. In their search for additional water supply the engineers said, "Let us reverse the flow of the Schoharie and carry it through the intervening mountain into Esopus Valley, and so make it serve as an additional feeder to the Ashokan reservoir." This involved the driving of a tunnel that measures 11 feet 6 inches by 10 feet 3 inches, for 18 miles through a mountain range which towers over 2000 feet above the tunnel. By means of this tunnel and a dam across the Schoharie Valley, will 250,000,000 gallons of water a day be rendered available for the use of a city about 150 miles distant from Schoharie. Thus, once more with characteristic modesty, has the man with the transit, the level, the notebook, and the drafting board, made a notable addition to the world's record of great engineering accomplishments.

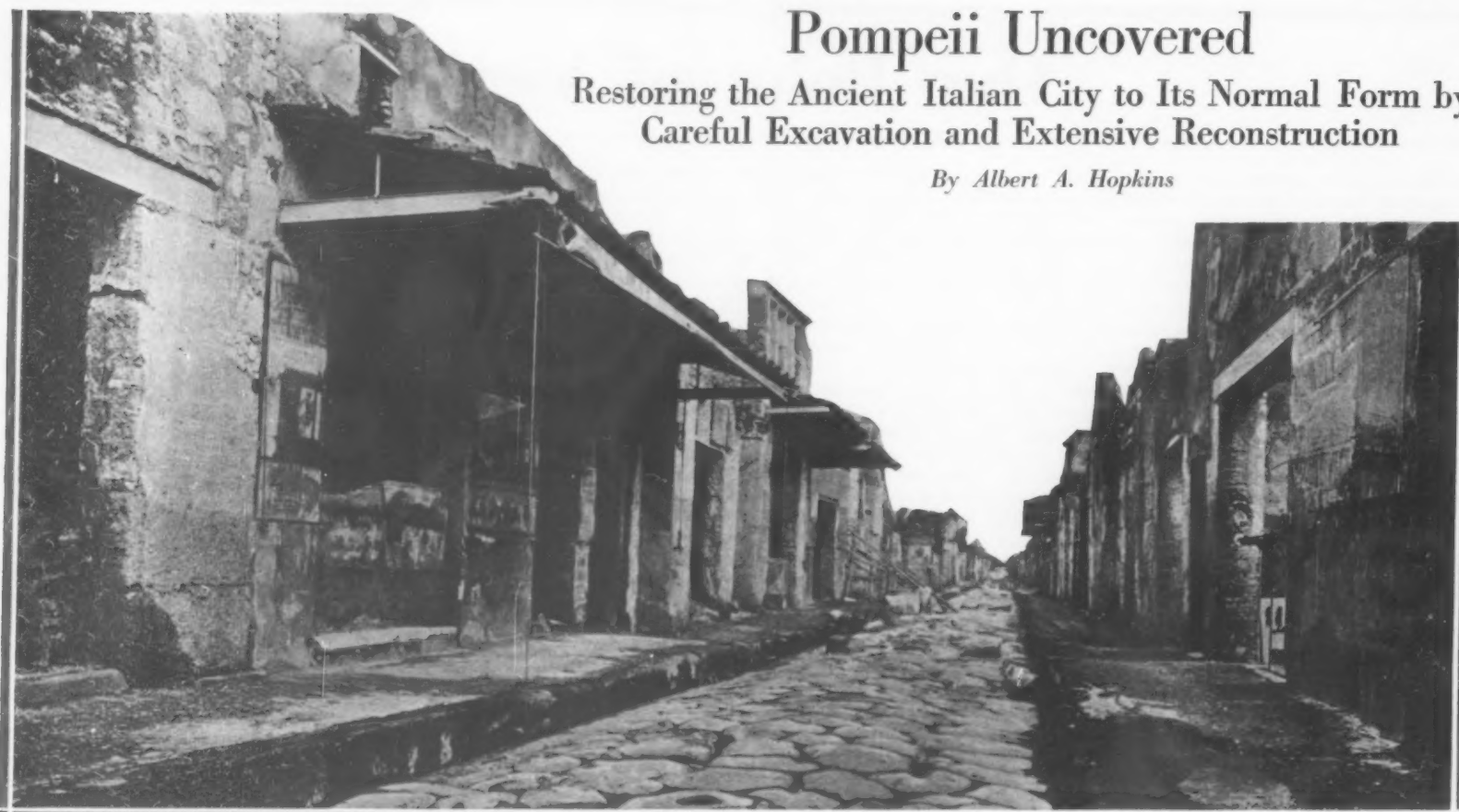
But after all we must remember that Shandaken Tunnel, in spite of its 18-mile length, is only one of a series of engineering works involved in supplying this city with water, that are equally spectacular, if we may use such a term. Greatest among these perhaps is the Aqueduct, 120 miles in its total length. This is nothing more or less than an underground river, which flows perpetually at a predetermined rate from a point 600 feet above tide-level in the Catskills to New York. In the course of its journey, on reaching the banks of the Hudson River, it drops 1200 feet below the surface of the river, turns a right angle, and flows at this depth beneath the river to its easterly shore, where it rises 1200 feet to follow its artificial underground channel to the city. Equally spectacular, though forgotten by all but a few, is the fact that when this river reaches the confines of New York, it drops vertically several hundred feet, and flows (at a depth, in one place, as far below the street surface as the Woolworth Tower soars above it) for the total length of Manhattan Island. Its channel below both the Hudson and Manhattan has been blasted through solid rock which had lain undisturbed for untold ages, until man by the aid of steel, steam, compressed air and the electric current, penetrated these silent depths, and wrought his way through, for the well-being and comfort of a modern world.

The Shandaken Tunnel, 18.2 miles in length, is the longest tunnel in existence. Travellers who have passed through the St. Gothard Tunnel in the Alps will be interested to know that the Alpine Tunnel is about one-half the length of Shandaken. The second longest tunnel in existence, odd to relate, is also found in the New York Water Supply System; being no other than the tunnel below Manhattan, above referred to, which is 18.1 miles in length.

# Pompeii Uncovered

Restoring the Ancient Italian City to Its Normal Form by  
Careful Excavation and Extensive Reconstruction

By Albert A. Hopkins



Illustrated London News

A newly excavated street in Pompeii showing shop fronts and second stories

**D**URING the European war, Italy, that excellent custodian of so much of the best of the world's art, was not idle as regards archaeological excavations at Rome, Ostia, and, best of all, Pompeii. The results at the last mentioned site are, to say the least, remarkable; and they are largely due to a new method by which the ground is not dug by means of pits and abrupt trenches, but is carefully removed by horizontal strata, descending only by degrees towards the ancient level, so that it becomes possible to catch and fix all the remains in their relative depth and position, and to preserve or restore all those parts of buildings, upper and lower, which have escaped total destruction.

The results from this new method of excavating have been of the highest importance as regards the private house, especially. We have been in the habit of thinking that the houses of Pompeii were like Oriental dwellings with few, if any, openings to the street. Quite on the contrary, the Pompeian houses are shown by the new excavations to have had plenty of windows, grouped in pairs, or three or four together like Gothic windows, even with projecting balconies and galleries, which enabled the inhabitants to watch the life in the streets of Rome's Newport or Atlantic City.

Under the new plan of excavation, everything is not carted off to the Naples Museum as soon as it is found. Instead, it is left intact wherever possible. The tiles have been restored to keep the sun off visitors as of yore; the carbonized beams have been restored with iron supports; and the gayly painted signs have been protected by glass. Formerly, casts were made only of skeletons; today, this plan is applied to everything decayed, such as furniture, wooden doors—where otherwise we should get only the metal nails—and even plants. So for the present, thanks to these Italian methods of archaeological research, we know what these ancient city dwellers grew in their window-gardens.

One of the newly-excavated houses has been restored, even to the ceiling of the upper floor, thousands of pieces having been painstakingly

fitted together. In one of the rooms a crystal lamp is still fixed to the wall, wanting only the wick. In the *triclinium*, or dining room—for the Romans of the period reclined instead of sitting at their meals—we have a table still set, while a space in the pavement shows that the food was brought up by a dumb-waiter.

The wall paintings are remarkable, and well preserved in consideration of what they have passed through. The shops did not hide their wares away from a buying public, but they blatantly advertised their offerings in every color of the rainbow. Sign painting must have been a good paying business, for the whole town seems to have been decorated with it, almost anything seeming proper material for the artist's skill. Theaters advertised their performances, the arena a gladiatorial show, as well as similar events out of town. Election appeals were popular and the sentiments, if not the medium, were dignified.

Among the interesting casts recently made is that of a man, molded where he fell in the volcanic ash during the great eruption of 79 A. D. Bodies and other objects were enveloped in fine white ash and tiny stones, which, becoming solidified in the process of time, and with the aid of water, formed a complete

mold, within which the contents crumbled into decay. Casts are made from these natural molds by pouring liquid gypsum into the hollow interior.

The most interesting casts have lately been taken, such as that of a folding-door of quite monumental size, still retaining its strong decorative large-headed nails, which was immediately replaced on its hinges. This was the door of a large mansion, certainly belonging to one of the wealthiest and most refined families in the town. The rooms of the large mansion were found adorned with splendid pictures of the fourth Pompeian style, and we can still admire on the walls of one of them, serving as the *triclinium* or dining room, the chief episodes of the Trojan war, executed by a painter of quite uncommon skill. The garden itself, like some others, has been revived with plants of the same kind as those which were burnt there 1854 years ago, since their roots could be recognized by means of casts.

The molded body of the old man, shown in one of our views, had leather slippers on his feet when found.

The new flood of light which the present excavations are throwing on Pompeii, is invaluable. The extensive excavations enable us to picture the town teeming with actual life. We are indebted for most of the foregoing facts to Prof. Federico Halbherr of the Italian Department of Antiquities, who selected the *Illustrated London News* for the first presentation in popular form.

The literature of Pompeii is very extensive, and runs the gamut from a wretchedly illustrated guide, sold at the gate for half a lira, to gorgeously illustrated folios, which are among the prizes of collectors. There are, however, a number of interesting points which might be gone into with advantage, as the references may not be easily accessible to all our readers.

The greatest use of Pompeii as an archaeological study is to give us a cross-section of what provincial life was like in the Roman Empire. Classical authors have handed down to us plenty of information as to life in that ancient metropolis, Rome, and we need only cite the writings of Cicero, Horace, Juvenal, Seneca and Martial. But Roman men of letters had a repugnance for the provinces,



Photo, Wide World

An aerial view of Pompeii, showing how the excavating has progressed



which explains their silence concerning them. Quite naturally, one does not care to speak or write of things which are displeasing; so the Roman men of letters have mentioned places other than Rome as little as they could possibly help, and what they have written teaches us nothing precise or new. Accordingly, we should now be hard pressed to describe life in a little town of the Roman Empire, if such a town, Pompeii, had not fortunately been found.

The discovery of Pompeii quite makes up for the silence of ancient writers. In order to know how people lived outside Rome, we need no longer gather, with great trouble, trivial and doubtful texts. A short walk through the excavated ruins of Pompeii teaches us infinitely more. We may make up our minds, before entering, not to find ourselves so far away from Rome as we might have been led to expect. Wherever an important capital existed in ancient times it exercised a strong influence on other towns, so that its very monuments were imitated, its fashions copied, its language reproduced, and its life used as a model of living.

In the first century A. D., the eyes of the whole world turned to Rome, whose usages had penetrated everywhere. Greek and Oriental civilizations resisted,

street, was faced to the interior, as is often the case in warm countries, such as with the "patio" of Mexico, Cuba, and even Spain. Among the ancients private life was more retired, more secluded than with us. The master of the house did not care to look into the streets except possibly from the upper windows, and, above all he did not want passers-by on the street to look into his house.

The Pompeian master had numerous divisions and distinctions in his own house. Thus the part where he received strangers was not the same as that where he retired with his family. Indeed, if some unwelcome caller became too insistent, there was often a postern door on an alleyway, making a sudden exit quite simple. From what has been said, however, it must not be inferred that the inhabitants were recluses or evaded society; on the contrary, they spent a considerable portion of their time away from home in the porticos, temples, baths, theaters and amphitheaters; but when they wanted rest and quiet they went home and got it.

The chambers of the Pompeian homes as uncovered are not large, but they are numerous. In the houses of the well-to-do there were rooms for all the avocations of the day. Each room was made exactly for the

present-day visitor some masterpiece of antique art, and enables him to enjoy it from memory. Occasionally there is a bronze imitation—the shops of Pompeii were full of them—of one of the finest works of Greek sculpture. The ancient owner knew its worth and placed it in his atrium, or his peristyle, to greet him each time he passed in or out. These rich Pompeians, or visitors, were happy folk. They knew how to beautify their lives without being over intellectual, and they were not specially religious; in truth, as far as we can discover the Christian religion never penetrated to this little municipality.

We have outlined some of the salient facts concerning the lives of the Pompeians having means, but there was also a poor population, to round out the scheme of community life. Pompeii was an industrious town. Considerable business was transacted there. Independent of its maritime commerce, it was a distributing center for fruits and wines. Its cabbages were famous. A Pompeian sauce, made with salted fish, was much esteemed all over Italy.

Besides the shops, which were numerous, there were hosts of peddlers who sold cakes, sausages, fish, and other comestibles. They were called "People of the



An old man in leather slippers molded in volcanic ash where he fell

A door 17 feet high restored by taking casts

feebly, it is true; but in the west, Rome was the conqueror and the arbiter. Spain, Gaul (ancient France) and Britain had all become, as it were, Romanized. Thus every city had to have its theater and its amphitheater like Rome, and in Pompeii we find a miniature copy of Rome, with none of her qualities, be they good or bad, eliminated. The public buildings of Pompeii were numerous and were normal to a place of its size. The situation was ideal, winter was of short duration, spring and autumn were long, and the heat of summer was not intense. The writer has been in Pompeii in late August without experiencing anything like the discomfort of a New York summer's day, humidity being conspicuously lacking. The early morning is apt to be hot, but by 10 o'clock there is a comfortable breeze, and at night there is always plenty of cool air. Comparing this to the stifling heat of Rome or Naples it is little wonder that the Romans were fond of this seaside resort, which was a microcosm of the capital.

There were probably 20,000 people who formed the average population of the city. Many lived there continuously and had expensive villas there, as many people now live in seashore resorts the year around.

The number of houses occupied by single families has been found very considerable. The wealthier inhabitants frequently occupied all of a very small block. Others leased out the front of their houses or the streets for shops, from which they derived a good rental. The house proper, instead of being faced on the

use to which it was to be put. Instead of a single dining room there were often several of different sizes, and for the changing seasons. The room in which C. Hostilius Conops, or M. Holconius Rufus, took his siesta in the day time, was entirely different from the one in which he slept at night. The bed rooms were terribly small; in fact, at this advanced age our enterprising Board of Health would condemn them as being unsanitary, for they were usually without light and air, except for a door.

Obviously, the Pompeian had no desire to remain longer than to gain a restful sleep, for most of his time was spent in his courtyard, called an atrium. It was sometimes closed in, more often open and surrounded by columns and called a peristyle. In this courtyard there was often a miniature garden, very much beloved by the old Romans, as well as fountains and miniature brooks. Beauty was the keynote of their homes.

The otherwise fatiguing glare of the white stones used in the houses of Pompeii is everywhere softened by pleasing tints. The walls are painted grey or black, and the columns toned with yellow or red. Along the cornices run graceful arabesques, composed of intertwining flowers, mingled at times with birds that never existed, or landscapes which have nowhere been seen. Fine mosaics, brilliant stuccos and incrustations on marble, serve to break the monotony. Now and then, upon some larger panel, a mythological scene, painted unpretentiously and in broad strokes, recalls to the

"Forum," and as each type of itinerant merchant had a different cry, the noise must have been intense.

In time we hope that the houses of the very poor man may be found and excavated, for the manners and customs of the lower orders still remain to be investigated. They probably had their own taverns, for all Pompeii seems to have been well provided with such institutions. However, all of these places were not taverns for dispensing wine, for many of them were devoted to selling hot drinks, the nature of which cannot now be determined. They were usually situated on a corner. There was a marble counter recessed to hold the vessels containing the hot drinks, and on shelves, at the back, glasses of different forms and sizes were placed. The whole outfit strongly suggests our soda counters of today, for such establishments were intended for those who wished to have their refreshment without sitting down as in a cafe.

Pompeii, the buried city of the past, is gradually coming into her own, and it really suggests a living town rather than one snatched from the embrace of the crater.

It would perhaps be appropriate to introduce at this point the story of an eye-witness of the great catastrophe—Pliny the Younger—which records the death of the elder Pliny, his uncle, who fell a victim to his inquiring spirit and humanity. There was evidently plenty of warning, and the younger Pliny, who was then

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# Tiny Air Bubbles and Giant Dams

## How Air Jets Protect a Great Dam Against the Destructive Fields of Ice

By S. G. Roberts

**A**IR bubbles as an effective defence against the crushing forces of ponderous ice fields—just think of it! The mere suggestion smacks of the fanciful, the impossible. And yet this dynamic paradox, so to speak, is a veritable fact, and is employed to advantage in the case of one of America's greatest hydro-electric developments—the Keokuk Dam.



A close-up view of the small tubing as first installed. Note the accumulation of ice on the air pipe where it enters the water. Subsequently, the pipe entered the water close to the front of the gate, and the ascending bubbles checked any tendency of the ice to form and to cling to the tubing.

One of the many pipes which create the bubble barrage

In the following account of what has been done at the Keokuk dam across the Mississippi will be made plain how kindred facilities may do equally helpful and protective work at other hydro-electric undertakings that are located in regions where ice ten inches and more thick is not uncommon during the cold months of the year. That an ounce of prevention is worth a pound of cure has never been more convincingly demonstrated than by the performance, under rigorous conditions, of the simple, ingenious, and, withal, cheap installation devised by the experts of the power company in question.

The Keokuk dam was reared across the Mississippi at the lower end of what used to be called the Des Moines rapids, is 53 feet high and 4649 feet in length. The upper portion of the dam, that is, the part rising above the permanent concrete spillway, is made up of 119 arched spans supported by piers six feet thick. The intervals between each neighboring pair of piers is 30 feet clear, and the 119 gaps are blocked by a corresponding number of steel spillway gates, 32 feet wide and 11 feet high, which can be moved vertically in slots or guideways formed in the piers.

The dam creates a lake which reaches upstream for

a distance of 65 miles and ranges in width from about one mile to several of them. This area of relatively still water lends itself in cold weather to the ready development of ice; and, inasmuch as the temperature sometimes drops to 25 degrees below zero, the ice field not infrequently attains a thickness of 20 inches.

Prior to the construction of the dam, the engineers assumed that the man-made lake, would offer a quiet basin for the ice field and that the ice would remain there at rest until it melted and was gradually dissipated with the coming of spring. Further, they counted upon the dam to hold the ice immobile until it was softened and no longer able to exert destructive forces. As a protection each pier on the upstream side was provided with a vertical projection, called a bullnose, designed to break the ice if the field moved downstream and threatened to bring dangerous pressure to bear directly against the spillway gates.

For substantially four years all went well with the dam so far as any menacing accumulation of ice was concerned, but during the rather severe winter of 1916-17 ice formed in the lake above the dam to a thickness of 22 inches, and the bullnoses failed to check the pressure and the moderate elasticity of the gates did not yield sufficiently to the ice field to prevent injury to the gates. Indeed, one gate was bent nearly to the point of failure and several others were deflected to a lesser extent, but so seriously as to emphasize the need of prompt measures to prevent the possible collapse of many of the gates, each of which would cost about \$3000 to replace.

As a means of immediate relief a slot was thawed by steam in the ice in front of each gate across the space between the flanking piers. This neutralized temporarily the horizontal pressure of the field and removed the thrust against the gates, but the remedy was an inadequate one, could not be brought into service quickly enough to keep all of the gates continually relieved, and was, besides, too expensive for practical requirements in the course of a prolonged cold spell. The situation revealed that it was imperatively necessary to develop an effective and relatively cheap agency which could be depended upon to do its work night and day and simultaneously from end to end of the upstream face of the dam.

The engineers were awake to the fact that their problem was not a simple one owing to the several ways in which ice can exert tremendous pressures; and it was equally manifest to them that the field should not be separated from the dam by a parallel area of open water, which might allow the great floating body to move down upon the dam so as to deliver a dynamic blow to the immobile structure.

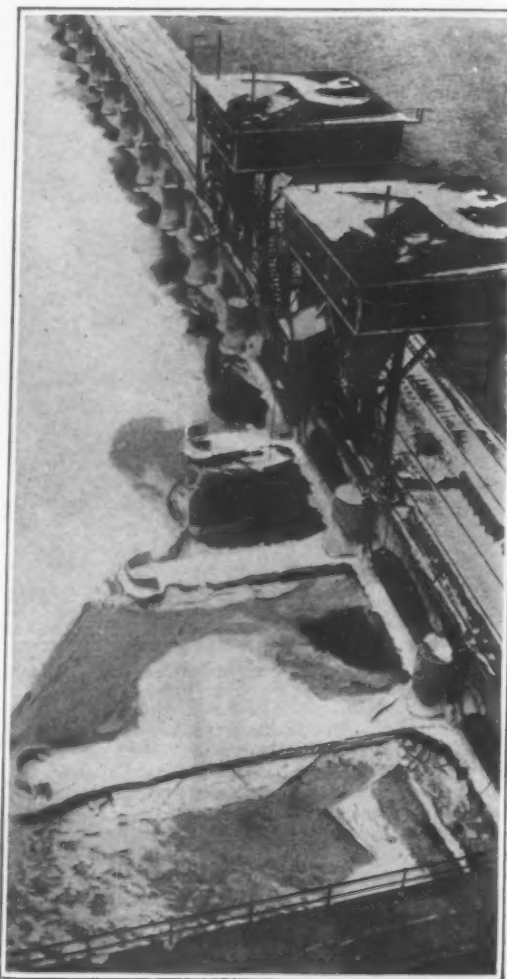
Experiments were carried out in March of 1917, and it was demonstrated then that compressed air could be used in lieu of steam to melt ice already formed and to prevent its reforming upon the water within a given area. This was accomplished by subaqueous jets of compressed air placed in front of some of the gates; and the ice so dealt with ranged in thickness from 10 to 22 inches. The rising bubbles of air, by agitating the water, caused the latter to wash away the ice, and, depending upon the vigor of the water's induced motion, this ice was thus cleared away for a radius of 10 to 15 feet from a single jet. Those tests led to the drawing up of complete plans and the installing of a plant which was ready for service in December of 1917.

The popular understanding is that ice exerts pressures of any moment only when it is in motion or packed up in the form of a jam with a considerable head of water tending to force it onward. This is not the case; and, therefore, there is all the more reason why dams exposed to ice fields ranging in thickness from 10 inches upward should be safeguarded, especially if they be equipped with spillway gates. For the sake of those unfamiliar with this subject, let it be recalled that ice is capable of generating pressure in three ways, namely: 1, by the freezing of water held in a confined space; 2, by the expansion of the mass of an ice field following a rise of temperature; and, 3, by the thrust or impact of a field of ice in motion.

As most of us have been told in our school days, water in turning into ice increases in volume 8.4 per cent; and it is conceivable that this change in displacement might, in some circumstances, prove a grave men-

ace to certain structural features of a dam like that at Keokuk. But probably the most dangerous pressures that have to be counteracted at the point under consideration are those set up by the expansion of a field in response to a general temperature rise in the icy mass. A bar of steel will expand when warmed or heated—that is common knowledge; but how many of us are aware that the coefficient of expansion of ice is four and a half times that of the metal mentioned? An abrupt rise in the atmospheric temperature of 20 degrees, for instance, might cause a field of ice to expand laterally and longitudinally about three feet each way; and if the field has an area of only one square mile the resultant pressure upon an arresting barrier would be enormous. Indeed, it has been demonstrated that a pressure of 133 tons per pier or a total frontal pressure of 15,828 tons has thus been directed against the upstream piers and the spillway gates of the Keokuk dam.

Visualizing the expansiveness and the incidental weight of the ice field pressing down upon the upstream face of the dam, only very simple protective agencies might appear unequal to the services expected of them.



The dark patches in front of each spillway gate show how the streams of air bubbles kept the ice away from the central two-thirds of each of these barriers and protected them from injurious ice pressures.

Graphic proof of the protective power of the air bubble

In front of each gate, extending outward and downward from a two-inch main that ran along the top and edge of the dam, was placed a single  $\frac{3}{8}$ -inch pipe which reached into the water to a depth of 18 feet—holding its upturned tip about six feet in advance of the gate it was to defend. The tip had a cap pierced by an orifice but one-sixteenth of an inch in diameter. At the time these slender tubes were connected with the two-

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### Curious Concrete Bridge Tests

A MINIAURE, one-quarter sized concrete skew bridge has recently been built at the Arlington headquarters of the national road engineers, which is to be investigated to destruction in the determination of perplexing highway problems which, hitherto, have baffled experts on concrete construction. A skew bridge is one that is built diagonally across a stream instead of being constructed at right angles to the waterway. Curiously enough, certain unusual complications in concrete construction and its ability to withstand heavy highway service have developed in these skew bridges.

In order to provide suitable laboratory facilities for studying all the service strains induced in these bridges when they are subjected to heavy loads, the Government has built a small edition of one of these bridges. It is not exactly a toy bridge, but it is only one-fourth as large as the usual type, being 7 feet long, 4½ feet wide and 4 feet in height above the base of the abutments. The crown or midpoint is two inches thick and the barrel of the arch is reinforced with one-quarter-inch bars bent very carefully into the correct shape. This model is being subjected to heavy loads and these loadings will be continued until the bridge is demolished. Detailed records and observations are kept of all the changes in length, shape and form that occur in the test bridge, as it is loaded with heavier and yet heavier burdens.

The testing appliances are so unusual that they are deserving of some brief description. They consist of 42 spiral springs, each of which is capable of carrying a load of 1500 pounds. They are placed at uniform intervals on top of the arch and each spring supports a two-inch pipe which, in turn, bears against a solid, overhead structure. By adjusting the lengths of these pipes the springs are deflected and the amount of load applied to the arch may be controlled by the amount the springs are compressed. In this way it is possible to obtain fine adjustments in the amount of load applied without the necessity for piling on heavy weights. As the load is increased the arch deflects and the concrete and steel are deformed or strained. The highway engineers have long been desirous of ascertaining how these strains are distributed, but these experiments are intended to supply very exact data on this interesting subject.

Special gages are used to measure the strains which are developed in the concrete. With these appliances it is possible to detect deformations with an accuracy of .0002 of an inch. By carefully measuring the strains throughout the arch it is possible to determine the manner in which the stress is distributed. The Government road builders believe that through a series of such tests they will obtain definite facts and figures which will enable them to correct previous weaknesses and errors in the construction of skew bridges. The experimental activities feature not only the determination of the strains that occur in the arch, but also observations of the measurement of deflection of the test bridge under load as well as a measurement of the stress in the tie rods between the abutments of the bridge.



By means of this model, one-fourth full size, tests are being made of the exact deformations of concrete roadway arches under given loading. View at right shows how load is applied through coiled springs which are capable of exerting pressures up to 1500 pounds

### A Rush Job in Dam Construction

DURING the winter and spring of last year there occurred a contest between man and nature, which certainly possesses a strong flavor of dramatic interest. It was a fight between the flood waters of a mountain stream and the dam builder, and resulted from an unusually wet season in which precipitation during a series of months was 200 per cent of that normal precipitation which the builders of the dam expected to prevail, and upon which they were relying to maintain the crest of the dam above the rising level of the impounded waters back of it.

Now all of this happened during the building of what is known as the Barrett Dam, which will form the latest addition to the water supply of the city of San Diego, Calif. The dam is located on the Cottonwood River at a point some 36 miles to the east of San Diego, and by the courtesy of Mr. H. N. Savage, Hydraulic Engineer for the city of San Diego, we are enabled to present the accompanying photograph and the following description of the building of the dam, and of the difficult circumstances above referred to. It seems that at the beginning of the wet season of the winter of 1921 to 1922 there was a rain storm of such unusual intensity that the rainfall in San Diego during December, 1921, was 9.26 inches, and for 24 hours—during December 25th to December 26th—the precipitation

that it became a question whether the engineers could carry up the concrete work at a speed sufficient to prevent any overflow. It was only by that careful planning and coordination of work, of which civil engineers have shown themselves to be capable in emergencies, that the race against the rising flood was won, if only by the very scantiest of margins. As a matter of fact, not a gallon of water got past the dam. What this means will be understood when it is stated that not only were the engineers able to retain the whole of the runoff from the drainage basin of the new dam, but also they saved one and one-third billion gallons that overflowed from Moreno reservoir, which had previously been built at a point farther up in the same drainage basin. Both Mr. Savage and Mr. W. A. Stebbins, the Construction Engineer at the dam and the force under him, are to be congratulated on the successful way in which the emergency was met. We are informed that the value of the water which had thus been retained by the time the dam had been carried to its full height exceeded the whole cost of the dam. Furthermore, had the race against time been won by the water, the overflow would have wrecked the concrete hoisting and distributing plant and would have flooded the sandpits, thereby preventing the completion of the dam during that season and losing one season's full storage capacity of the reservoir.

In meeting the emergency, both ends of the dam were built up in advance of the center; this to protect the abutments at each end. Moreover, in view of possible emergencies, temporary sluiceways were built and maintained through the central portion of the top of the structure. How close was the contest is shown by the fact that the reservoir level was continually near the top of the center of the dam and was almost continuously higher than some parts of the concreting.

To hold back the water, wooden forms, backed up by concrete, were placed on the upstream side, and there were times when the crest of the dam sloped from the upstream edge down to a level, on the downstream edge, of fully 10 feet below the level of the water in the reservoir. This condition is shown very clearly in our photograph, in which the upstream wooden forms are seen to the left, with the concrete being poured in such a way that it stands much higher on the upstream than on the downstream side of the dam.



Feverish construction of Barrett Dam, Calif., to maintain its crest above the rapidly rising flood waters. Note the reservoir water is several feet above the lower edge of crest of dam

# Current Psychic Investigation in Europe

Statements from Well-Known Psychic Workers, Baron von Schrenck Notzing and Mme. Bisson

Secured for the SCIENTIFIC AMERICAN by Dr. A. Gradenwitz, Berlin Correspondent, and presented with editorial comment

**S**IR William Crookes was the first modern scientist to investigate, in scientific fashion and with the use of apparatus, the phenomena of psychism. When he first stated his intent to do this, the announcement called forth universal approval. "Profound satisfaction that the subject was to be investigated by one so thoroughly qualified"; "gratified to learn that the matter is now receiving the attention of cool and clear-headed men of recognized position in science"; "Mr. Crookes' ability to conduct the investigation with rigid philosophical impartiality"; "we shall soon know how much to believe"—these are fair samples of the comment offered by the contemporary scientific press.

But in the *Quarterly Journal of Science* for October 1, 1871, Crookes had occasion to complain that these endorsements of his project had been hastily written. "It was taken for granted by these writers," he points out, "that the results of my experiments would be in accordance with their own preconceptions. When they found that the facts which my investigation established could not be made to fit these opinions, why—so much the worse for the facts." So wrote this distinguished scientist over a half-century ago.

Sir William Crookes was the first scientist to be told that, so long as he confined himself to things that everybody knew, he was an eminent personage and a man of wisdom and ability; but that when he branched out into untrodden fields he was a silly old man in his dotage, being imposed upon by clever tricksters. But if he was the first scientist thus to discover that research in new fields is not the business of science, he was far from the last eminent investigator who has been castigated, by his less imaginative colleagues and by the wholly unimaginative public, for daring to postulate that we do not necessarily know everything that it is profitable to know. The present generation includes a long list of men who have been thus abused for their willingness to believe that there may yet be something to learn, and for their presumption in trying to learn it. It is the intent of the present article to permit several of these gentlemen to speak for themselves. And first of all we shall hear from Dr. A. Baron von Schrenck Notzing, author of "Phenomena of Materialization," investigator of psychic phenomena for many years, and lately sponsor of the remarkable medium Willy Sch.

The Baron feels that the storm of indignation, reckless criticism and violent onslaught to which the appearance of the first edition of the book mentioned above gave rise, has during the intervening eight years given way to a more serene and objective appreciation of the problem of mediumistic materialization. "In fact," he insists, "this adverse argumentation on and objection to the achievements of his medium have without exception, on careful investigation, been found absolutely untenable. Most objections are based on a regrettable want of actual knowledge, due to a superficial perusal of records and to the strong bias likely to arise out of the contemplation of photographs presenting an unconvincing external appearance.

"An exceptionally thorough-going verification of the mediumistic achievements of the Parisian medium Eva C. has been made, especially by Dr. Gustave Geley and by the Commission of the British S. P. R., fully bearing out the results reached by the writer and Mme. Bisson. In fact, the photographs of phenomena as obtained by French and British students are accurately like our own; and all details of our investigations, such as the imperfections and insufficiencies of presentment with their characteristic peculiarities, their disproportions, deformations, fissures and folds, are here verified in every detail, despite the possibly even more stringent experimental conditions. And this is not all; Eva C. will today, under considerably improved lighting, even in partial daylight, produce the same partial materializations in bizarre and fantastic forms. Moreover, the teleplastic morphogenesis of elementary substance has been enriched considerably by Richet's ob-

servations on Eva, made quite independently of our own studies and but recently published. To this should be added the positive accounts of numerous eye-witnesses belonging to the most varied professions.

"This long series of observations and verifications, continuing for nearly 14 years, affords an exhaustive picture, an overwhelming evidence, of the reality of Eva's materializations, such as would have been deemed necessary in hardly any other doctrine. Any further doubt, any further objection possibly arising in future, could only be the outcome of prepossession, malevolence or ignorance, and may without hesitation be dismissed.

"That these phenomena of materialization are processes controlled by physical laws is strikingly shown by the uniform occurrence of the same phenomena in the case of other mediums. Quite aside from his former sittings with Palladino and others, the writer has himself, since concluding his investigations on Eva C., been able to make analogous observations quite recently on no less than four different persons. In one case, in the course of a six months' investigation in his own laboratory at Munich, the writer was even in a position to demonstrate the telekinetic and teleplastic achievements of Willy Sch. before 23 German university teachers, 18 medical practitioners and 19 other men of science. Another welcome supplement to this comprehensive body of evidence is Dr. Gustave Geley's excellent report on his recent intensive in-

sults. He describes the essential factor of life, which is different from physico-chemical energy, and describes it in terms making clear that it controls also those parabiological processes which are met with in the phenomenon of materialization. Ectoplasmic morphogenesis would accordingly mean a new phase of biology, opening up unthought of tasks and possibilities to future science, and leading us to that borderland where energy and matter are one, and where in the various stages of materialization from the nebulous invisible emanation to the fully developed stereoplasm, they give evidence of a dominant organizing dynamism, manifesting itself outside of and apart from the body."

To those readers who feel that there is nothing essentially new in these ideas, we would point out that Schrenck Notzing here formulates them with far more boldness and precision than it is customary to formulate them; and that, coming from one in his position, the statement that we quote is in any event one of extreme interest. The obvious comment that all he does is to point out the probability that we may be dealing with a new force, as yet neither identified nor understood, does not do justice to the very admirable presentation which he has made of this doctrine.

Through the energy of Dr. Gradenwitz, our Berlin correspondent, we have a statement from Mme. Bisson, as well as the above from the Baron. Mme. Bisson, it will be understood, is Eva's patron. "Since 1909," she says, "Eva has never worked without me and has been

hypnotized by no one else." Most of Mme. Bisson's statement is given over to direct comments upon, rejoinders to and criticism of Mr. Black's article in which Eva, as well as Ada Besinnet, was very harshly dealt with. We believe we have said enough about this article, and therefore abstract from Mme. Bisson's text only such material as is of more general pertinence.

Mme. Bisson points out that, so long as psychic science remains so wholly a matter of description and so little one of concrete theory, it is unjust to make too sweeping generalizations. Every medium, she points out, has different powers and procedures, and criticism must deal with them individually rather than collectively. The mediumship of Kluski, for instance, "who never gives any phenomena save in complete darkness, will not bear comparison with that of Eva, who never works in the dark. While both these subjects are invaded by 'forces' similar in origin,

the manifestations of these forces in the two cases are altogether different. The visible and tangible substance given by Eva, a substance endowed with a life of its own and able to transform itself into faces, hands, entire figures, should not be confused with the invisible force which, in the case of Kluski, lifts tables and chairs and produces molds.

"One who says that the substance produced by Eva will 'shrink from any contact' proves the insufficiency of his information. At my home, with Eva, all those present could by direct contact satisfy themselves of the reality of apparitions. Moreover, it is a well known fact that such contact will cause all manifestations to be reabsorbed almost immediately. All that is asked from observers is a promise not to seize the substance abruptly, in order not to harm the subject.

"Contrary to the usual statement, the substance does not dissolve in the light—not even in daylight or under a magnesium flashlight. The medium is hurt by too brilliant an illumination, and tries to protect her face; but this by no means precludes the taking of photographs. The subject prior to every seance is undressed, searched, and dressed again in blouse and tights. She is never told when photographs are to be taken.

"The substance emitted is reabsorbed again; and its disappearance is extremely rapid, irrespective of the dimensions of the phenomenon. The chemical analyses that have been published have been of minute traces remaining behind on the medium's garments.

"It should be stated that Eva never enters trance of her own accord, but always under hypnosis."

Mme. Bisson closes her statement with a curiously worded, semi-denial of Eva's Algerian record.

(Continued on page 286)

**W**HETHER Mr. James Black's articles were fair or not, they represented the reaction toward psychic investigation of the hard-headed person who is convinced before he starts that there is nothing in this subject—that the so-called psychic phenomena cannot and do not happen. As such, it was a contribution to the literature of the subject. Its insertion, however, puts us under the obligation to give equal freedom of speech in our columns to those who are convinced that psychic phenomena do occur, and who are in a position to insist with effect upon this opinion. Dr. Gradenwitz has volunteered to get such a statement from several of Europe's leading investigators; and, not without difficulty, he has succeeded in this effort. The by-line at the head of this page indicates sufficiently the character of the present article. In a future issue we shall have one or more similar articles setting forth the views of Dr. Fritz Grunewald of Berlin, Dr. Geley to whom Schrenck Notzing refers in the accompanying text, and perhaps one or two others.—THE EDITOR.

vestigations of the Polish medium, Franek Kluski.

"An attempt has been made in the writer's work to describe as accurately as possible, as well as to compare and coordinate the results of investigation by the writer and others. Like all natural sciences, metaphysics is a descriptive doctrine—despite the strangeness of its phenomena. To explain it and discover its underlying causes is the task of philosophy.

"Physical mediumship is putting science before new tasks. Necessary though it be to ascertain these phenomena objectively by means of photography, weighing machines and other registering instruments, it still seems as though the physico-mathematical method of investigation alone is insufficient. The difficulty is not so much that of observation as it is the inherent uncertainty of psychodynamical processes which, the same as with the act of artistic creation, are to a high degree dependent upon the psychic disposition of the subject and the mental atmosphere of those present. The failure of most investigations by scientific commissions is due to the fact that this decisive factor is ignored or misunderstood.

"The existence of teleplastic products themselves, their visibility and ephemeral life, are closely connected with the psyche of the medium and of the sitters. They are in the true sense of the word, mental creations personified, embodied dream pictures, owing their existence to an as yet unknown transformation of biophysical forces in the medium. From the scientific viewpoint teleplastics is thus in the first place a biological, and in the second place a psychological problem. But even in biology, without the psychological complication, mathematical-mechanistic science, as proved by Prof. Driesch, fails to give conclusive re-



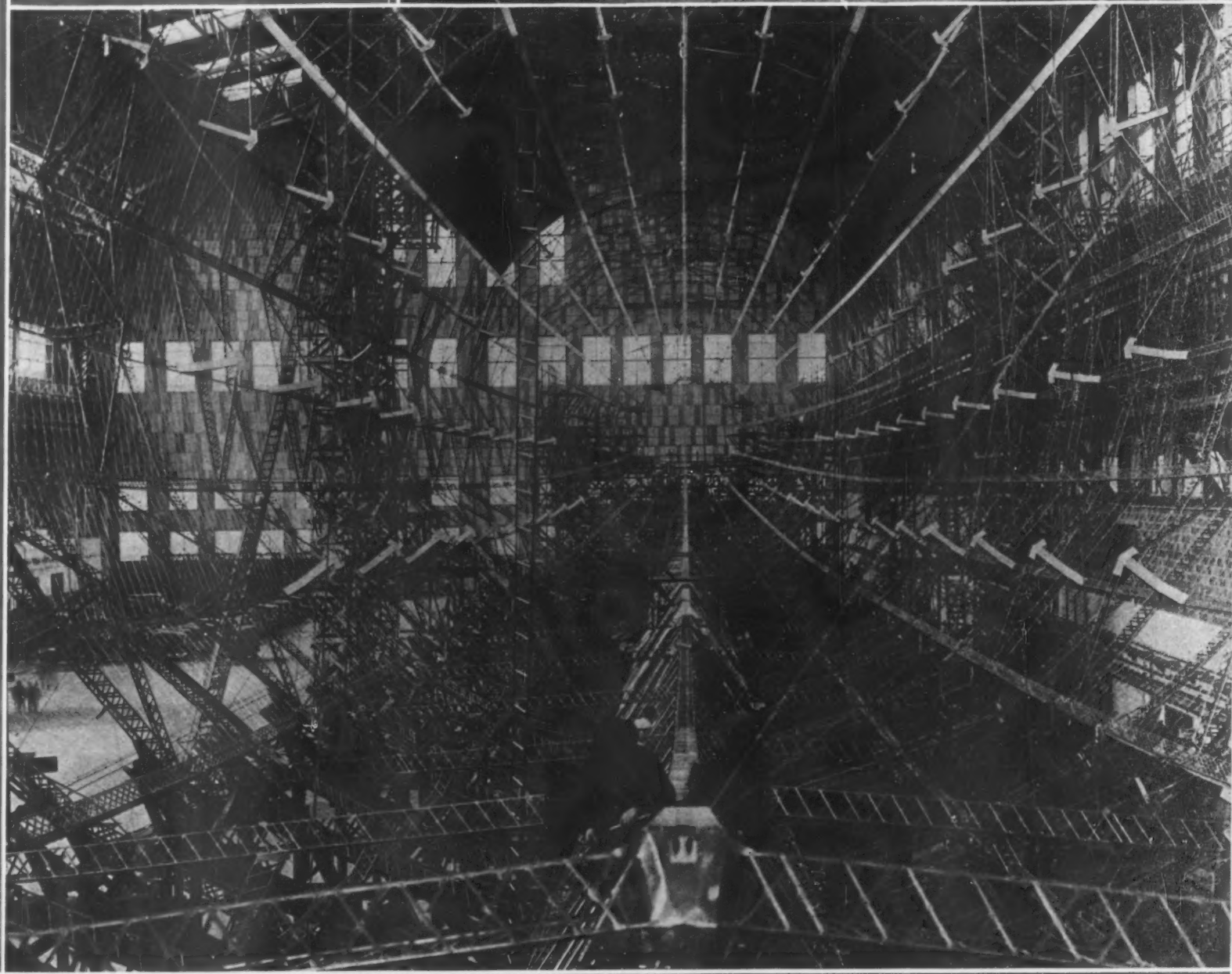
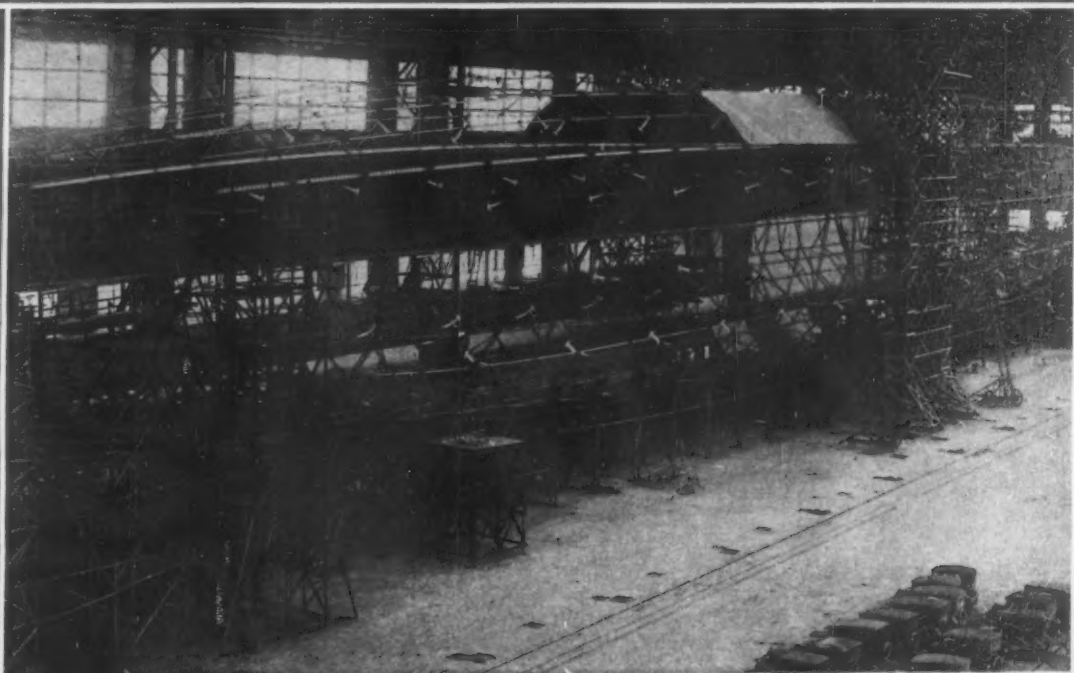
### Our Giant ZR-1 in the Making

THERE is being constructed in the huge Naval Air Station hangar at Lakehurst, N. J., our naval airship "ZR-1." Despite the unfortunate career of the British-built "ZR-2" and the Italian-built "Roma," we have undertaken the construction of our first American-built Zeppelin type airship.

The two accompanying views show the "ZR-1" under construction in the largest single room in the world, with 804 feet by 264 feet clear floor area under one roof, and with a height of 192 feet. Note the automobiles lined up in the right foreground of the upper or side view of the huge skeleton.

The "ZR-1" will measure 680 feet in length, and 93 feet high as measured from the top of the envelope to the bottom of a gondola. Our second or bottom view is looking through the center of the cage-like skeleton. The greatest diameter will be 78.7 feet. The gas bags will hold a total of 2,115,000 cubic feet. The power plant will consist of six 300-horsepower engines, giving the airship a speed of 60 miles per hour.

The "ZR-1" is intended as an aerial scout for the Navy, and as such it will have a crew of 23. According to plans, the "ZR-1" should be ready for operation by July 1 of this year. The "ZR-3," another Zeppelin type rigid airship, under construction in Germany, may be delivered to us some months later.



TWO STARTLING VIEWS OF THE NAVY ZEPPELIN AIRSHIP "ZR-1," IN COURSE OF CONSTRUCTION AT THE LAKEHURST, N. J., NAVAL AIR STATION

### Broddingnagian Coffee Urn

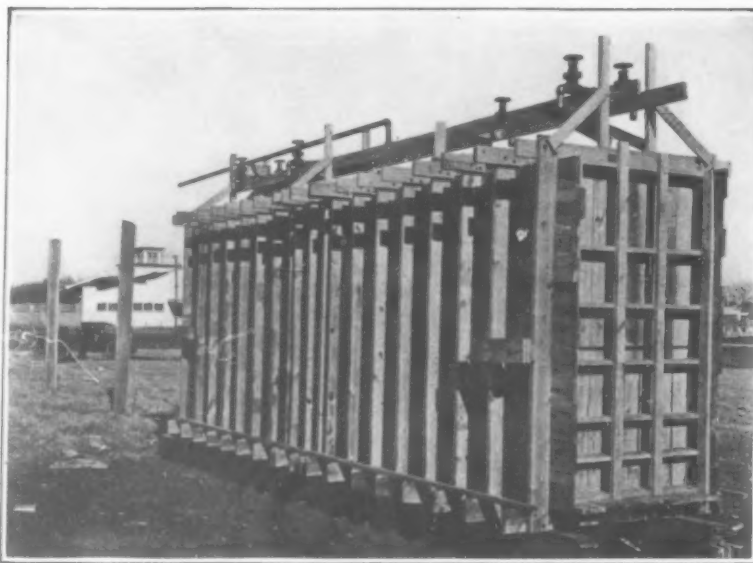
THEY certainly do things on a big scale "out West." If you need to be confirmed in this belief, just cast your eye on the accompanying photograph, showing one of a group of four of the biggest coffee "urns" in the world, each holding 10,000 gallons of coffee, and all four built to provide 480,000 cups of the delectable liquor for the good cheer of 125,000 Oklahomians, who recently swarmed to Governor Walton's election barbecue on the occasion of his inauguration. Ten steam boilers developing 250 horsepower were required to make this enormous brew; and to satisfy the thirst of the throng 11,200 pounds of ground coffee were required. Mr. C. E. Van Cleef, who supervised the construction of the tanks, tells us that they were each 24 feet long by 6 feet wide by 8 feet 10 inches high. As will be seen from our picture, they were built up of planking, held in place by rather closely spaced verticals, which were bolted to transverse timbers respectively at the bottom and top of the tanks. When the urns had been lined with tin, they were proof against leakage. Along the bottom of each tank were 32 faucets, from which the guests were able to draw their own coffee. For cooking purposes a steam line was laid from the ten steam boilers above mentioned, and this was connected with two perforated pipes in the bottom of each tank, through which live steam was introduced to heat the liquor and cook the coffee. Twenty-eight hundred pounds of ground coffee, packed in 25-pound cotton sacks, were suspended in the liquor from the top of each tank. After the introduction of the ground coffee the temperature was held from 212 to 215 degrees for 40 minutes, and this brought the liquor to the proper color and strength.

### A Reservoir with Cathedral Architecture

THE city of Cleveland, Ohio, is completing a covered reservoir built of reinforced concrete, which is remarkable in more ways than one. This work forms a section of the new city filtration plant. The outstanding features of the Baldwin reservoir, as it is called, are its great area, its unusual depth, the fact that it is built in a large excavated basin which is so deep that the roof of the reservoir is about flush with the surface of the ground; and finally, it will command widespread interest from the peculiar cathedral-like character of its construction. After the basin was excavated the floor was leveled and covered with a 9-inch slab of concrete, and upon this floor was erected a veritable forest of circular reinforced columns which serve to carry a groined concrete roof, at a height of nearly 40 feet above the floor of the reservoir.

The reservoir, which is 1135 feet in width, is divided into two equal parts, known respectively as the east and west basins, by a heavy, reinforced-concrete wall which rests upon a concrete base 29 feet in width and 18 feet in depth. The wall proper is 8 feet thick at its base, from which it tapers to a thickness of 4 feet at the springing of the groined arches of the roof. Each of the basins, therefore, measures about 510 feet by 550 feet in area. The circular columns, which are reinforced both vertically and horizontally, are 2 feet 6 inches in diameter and extend without any taper from base to spring-line of the arches. Both base and capital are flared, as shown in the accompanying photograph. The total height of the columns from floor to the springing of the arches is 35 feet. The roof is of the simplest groined type, without any ribbing, and thus takes one's mind back to the very earliest type of vault, as used in Roman and early Gothic construction. The clear height from the floor to the ridge of the vaulting is 39 feet.

The accompanying photograph, for which we are indebted to Ottomar Stange of the contracting company, Cleveland, Ohio, is very impressive and to many of our readers will be curiously suggestive of the columns and vaulting of early Romanesque and Gothic cathedrals. The



One of four 10,000-gallon coffee urns built to provide nearly 500,000 cups of coffee for the 125,000 guests of Governor Walton at his inaugural barbecue at Oklahoma City

columns are spaced 20 feet  $3\frac{1}{2}$  inches in each direction, and in order to stiffen this great forest of piers, with their vast supported roof, each central line piers in each section of the reservoir is stiffened by connecting them with a continuous wall 15 inches in thickness, extending from floor to roof.

The magnitude of the work will be further appreciated when it is stated that there are two great approximate squares of roofing measuring about 500 feet on a side, each square being made up of 1104 groined, arched panels, resting upon 1196 columns of the size and height above given. The floor is divided by expansion joints into sections 20 feet square.

In carrying out this great work, there were handled 57,000 cubic yards of excavation and 215,000 cubic yards of fill. There was built into the reservoir 104,100 cubic yards of concrete, and 1750 tons of steel.

Anyone who has followed thoughtfully the progress of engineering works in this country must have been



No; this is not the nave of a cathedral, but one aisle of the new concrete-covered reservoir at Cleveland, Ohio. The reservoir is 500 by 1100 feet by 39 feet high from floor to groined roof

impressed with the ever-increasing magnitude of individual works, whether in the field of mechanical or civil engineering, and the dimensions of this remarkable Baldwin reservoir are a case in point.

### When the Gasoline Tractor Plays Switching Engine

OUR cover illustration represents an interesting application of the usual gasoline tractor. In order to save time and reduce operating expenses, a large industrial plant has been making use of a small gasoline tractor for switching freight cars about on its extensive railroad sidings. The powerful little tractor shown in our painting can readily handle the average loaded box car, the brakes of which are applied at the proper time by a brakeman. The tractor saves considerable time over the usual switching locomotive, because of its ability to go from one track to the other with the minimum of travel and switching. It is only necessary to turn the tractor at right angles to the track and ride over the rails to another track where cars are to be handled.

Switching locomotives are not always available when they are desired, hence the tractor comes in for some real work in the busy industrial plant with extensive sidings. If anything, the gasoline tractor is even better than the electric winch arrangement used in some industrial plants for hauling cars along by means of a heavy hawser which is wrapped around the winch and fastened to the car to be moved but a short distance.

### An Electron Tube Amplifier Using A. C. Current for Filaments and Plates

SCIENTIFIC Paper No. 450 of the Bureau of Standards, obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents per copy, describes an electron tube amplifier which uses 60-cycle alternating current to supply power for the filaments and plates. This method, on the face of it, tends to simplify radio.

Such an amplifier has the advantages of low first cost and cheapness of operation besides doing away with the inconvenience of the storage battery and the "B" battery.

The amplifier developed at the Bureau of Standards uses a crystal detector and five stages of amplification, three stages of radio-frequency amplification and two stages of audio-frequency amplification.

The first arrangement tried consisted of one radio-frequency stage of amplification, tube detector, and one stage of audio-frequency amplification. The filaments of the three tubes were lighted by six volts supplied by a step-down transformer, the primary of which was connected to 110-volt, 60-cycle power mains.

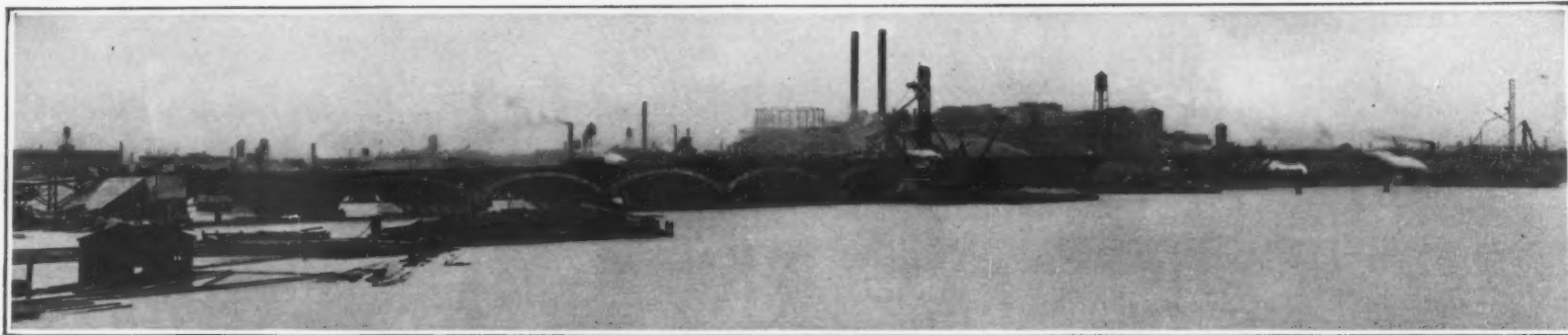
The alternating current was rectified by means of a gas-filled two-element rectifier tube called a "Tungar" tube, but it was found that the residual hum was greater than when the alternating current was not rectified.

When an electron tube is used as a detector there is impressed on both the plate and filament a 60-cycle, alternating-current voltage, which, although small, becomes objectionable when amplified by one or two stages of audio-frequency amplification. When, however, a crystal detector is used instead of an electron tube detector, it has been found that the 60-cycle hum is practically eliminated, and that the crystal gives as good rectification as the tube detector.

After much experimental work, a circuit consisting of three stages of radio-frequency amplification, galena crystal detector, two stages of audio-frequency amplification, loud-speaking reproducer, and the necessary power transformer and rectification circuits was developed which allows the reception of music and telegraphic signals without eliminating the residual hum.

Just recently there has appeared on the market a power amplifier operating on 110-volt alternating current or direct current circuits.





Handsome arched cantilever bridge, built of steel and concrete, between Belle Isle and Detroit, Mich.

### Floating a Bridge Into Place Section by Section

THERE is now being built, between the city of Detroit and the City Park on Belle Isle, a bridge of steel and concrete, which will not only be of great convenience to the citizens, but, as our photographs show, will be a structure of decided artistic beauty. The spans, which vary in length from 74 to 135 feet, are in the form of the shallow but very graceful elliptical arch, which first made its appearance in the Middle Ages in the beautiful Trinity bridge across the Arno, Florence, and is now being used extensively in this age of steel-and-concrete bridge construction.

The technical interest in the Belle Isle bridge lies in the novel methods adopted by the Wisconsin Bridge and Iron Company in its erection, which is being done by erecting one center pier and the two adjoining halves of each span near the shore, and then floating the unit as thus assembled on scows, towing it to the site, and placing it in position on the respective concrete piers. Each span of the bridge is made up of two cantilever arms and a short center span suspended between their opposite ends. The steel framework was so proportioned as to carry its own weight together with that of the concrete and forms of the ribs. The load of the steel structure of the deck and the concrete pavement, and the live load of the traffic, will be taken by the concrete and the steel work conjoined. Each unit of a pier and two half ribs was erected on pile bents on the shore. First the tower was erected and bolted up and then the two half ribs, which had been previously assembled and bolted up, were swung into place, connected to the tower and supported near their outer ends on false work. As will be seen from our sketch, the two half spans were tied back to the central tower by I-bars, there being one set to each rib of the span. After this was done the steel framing of the deck was erected. It should be mentioned here that all of the work up to this point was connected up by bolting.

For moving each unit to the site of the bridge two scows 102 feet in length were floated under the haunches of the half arches. Upon the deck of each scow were adjustable bents, which were so arranged that they could be brought to a snug bearing against the lower chords of the ribs. After this was done, the scows were raised by slowly pumping them out, the pumping being continued until the scows had lifted the steel work clear of the fixed false work upon which it had been erected.

The next step was to tow the scows to a point upstream above the pier upon which the bridge unit was to be placed, and then guide the scows slowly down to the pier, their movement being controlled by a tug and by mooring lines. When the holes in the base of the steel tower were properly centered over the concrete pier, the bridge unit was lowered carefully on to the pier by flooding the scows. After the steel bridge work was in place and secured by the holding down bolts, further water was admitted until the scows had sunk clear of the bridge, when they were pumped out and returned to the yard. The various units of steel work moved and put in place in this manner ranged in weight from 100 to 230 tons, and it has been found that two units

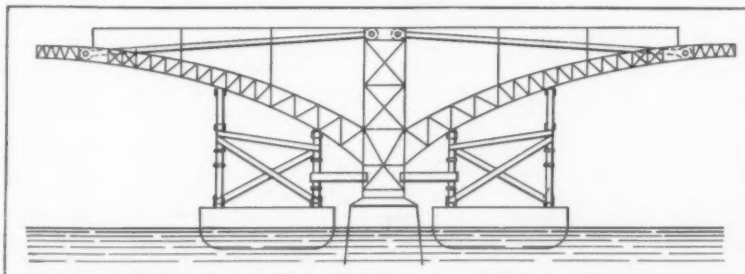
can be put together on shore, floated out and placed upon their piers in ten days' time. It should be mentioned that the total length of the bridge is 2200 feet, and the speed with which the work is being done is largely attributable to the novel erection methods.

### Effects of Local Conditions on Radio Direction-Finding

MESSRS. SMITH-ROSE and Barfield presented before the Radio Research Board (British), at a recent meeting, a report on the effects of local conditions on radio direction-finding. The methods used for finding the direction in which Hertzian waves are incident at a radio station have now attained a high accuracy, the maximum error being well under one degree. It does not follow, however, that the methods give the direction of the sending station to the same accuracy. The waves sent out may have suffered reflections from all kinds of conductors before they reach the receiving station. Hence, especially at night-time, the apparent direction generally differs very

finding station, for example, was erected on what was thought to be a favorable site. The errors found, however, indicated the existence of a long strip of metal in the neighborhood in a definite direction. The authors investigated the cause and found that a sewer in the neighborhood, which was in the given direction, was supported by a strip of steel 6 feet wide, 300 feet long and 8 feet below the surface.

Overhead wires also caused appreciable but variable errors, which the authors traced to variations of the telegraph and telephone circuits when in use. They investigated the errors produced by tuned aerials and trees. Trees when damp have small resistance, and so the oscillations set up in them affect the direction of the waves. A row of damp trees forms a very good conducting screen. It was noticed that the waves showed a tendency to move round large conductors. Owing to variable meteorological conditions a very large number of experiments had to be made before definite results were obtained.—Abstract from article in *Nature*, December 2, 1922.



Each erection unit (a tower and two arms) was floated into position on scows

appreciably from the true direction. The causes of distortion were classified under two heads: First, those which are vaguely classed as night-effects and occur between sunset and sunrise. They are sometimes as large as 20 degrees, and little is known as to their cause. Hence in practice radio-direction finding is restricted to day-time. The second causes of error are those due to conducting substances in the immediate neighborhood of the research coil. In one experiment a metal tube 50 feet long, semi-circular in cross-section, and of radius 3 feet 6 inches, was used. When the coil was at a distance of 15 feet from either end, errors became appreciable, and when placed 15 feet inside the tube the error was as great as 29 degrees.

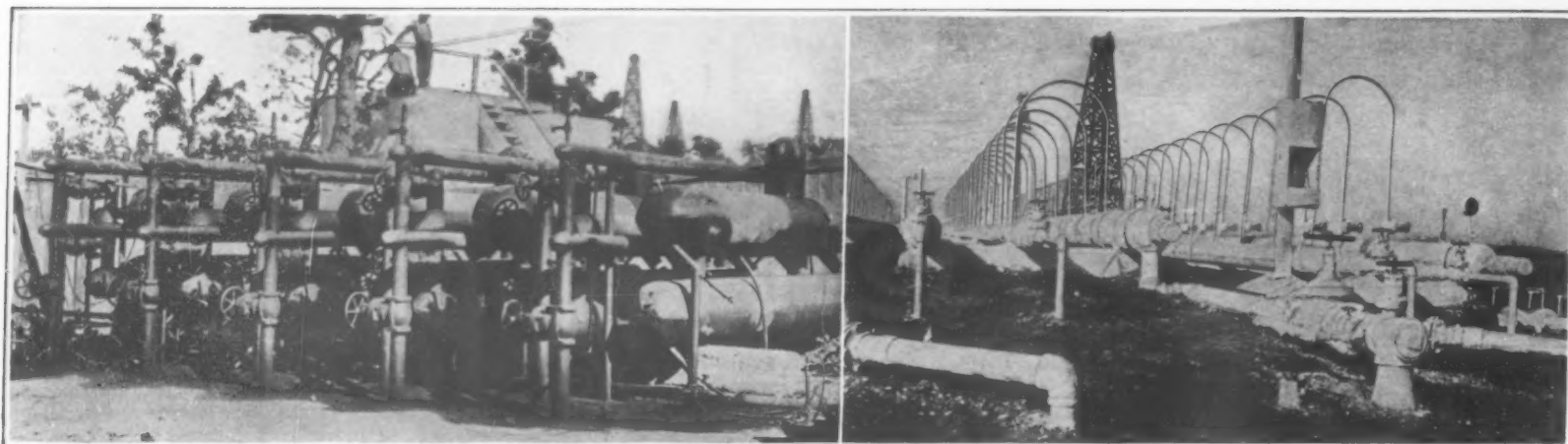
Experiments were also made on board ship, as radio-direction finding is of great value in navigation. It was found that when the waves came fore and aft or athwart the ship, there was no error, but that in intermediate positions the errors were sometimes as great as 22 degrees. As these errors are approximately constant, corrections can be applied as in the case of the magnetic compass. Curiously enough it was found that underground metal work in the neighborhood has a very appreciable effect on the apparent direction of the incoming waves. The Aberdeen University direction-

15 centimeters long, lies parallel to the surface and about 0.5 centimeter from it. At the bulb end the stem is curved so that the bulb (of rather larger size than in a clinical thermometer) lies along and almost touching the surface. Actual contact is effected by a thin flat copper plate lying on the surface and attached to the bulb, which itself is copper-plated on the outside. The under surface of the plate is roughened, and its relatively large surface (it is about 1 centimeter wide) quickly takes up the temperature of the rock by conduction and radiation, and conducts the heat rapidly to the glass bulb. The upper surface of the plate, and the plated surface of the bulb, are polished to prevent radiation to or from the surrounding objects. The bulb is further insulated by a polished reflector which covers it almost entirely, and prevents radiation while also reducing conduction of heat by air currents. The reflector is gilded in order that it shall not become tarnished. The mass of the bulb is small, so that it possesses little thermal capacity and scarcely disturbs the condition of temperature existing before placing the bulb on the rock; the thermal inertia is also small for the same reason. The makers state that on holding the bulb near to the side of the radiator with the polished surface facing the radiator, the thermometer shows no

change of reading, but on turning it around so that the flat copper plate faces the radiator, the column at once begins to move. This thermometer should have a number of interesting uses when the present types cannot be used with accurate results, particularly for building material heat-insulation tests.—Note from *Nature*, April 29, 1922.



This view shows one unit on its pier and another being towed to position on a pair of scows



Left: Horizontal absorbers for extraction of gasoline from lean gas. Right: Compression trap for casing-head gasoline in a California field  
Typical apparatus for recovering gasoline from natural gas

## Gasoline from Natural Gas

How \$200,000,000 a Year is Saved from Waste, and a Billion Gallons Added to the Gasoline Supply

By Guy Elliot Mitchell

United States Geological Survey

**T**AKING salt out of air to the extent of hundreds of millions of pounds a year appears to be something of a scientific triumph when you come to think about it. This is being done in various countries, through the use of cheap water power, and is what Henry Ford proposes to do if he gets title to the Government Muscle Shoals nitrogen producing plant. Stripped of technicalities the process may be described simply as condensing the inexhaustible nitrogen gas of the atmosphere into nitrate of soda, a salt whose appearance resembles almost exactly common coarse salt. If ground up fine it would pass readily for common table salt, but it would not be well to sprinkle it freely on your food. Nitrate of soda is a necessity in making war explosives, and it is a great fertilizer, but it is not good food except for munition plants and farm plants. Cattle which have chewed up burlap bags that had contained nitrate of soda have turned up their toes to the daisies.

So much of comment on the ingenuity of man which has made possible the extraction of a tremendously important salt from thin air; no less strange seems the idea of producing millions of gallons of gasoline a year from the odorless, colorless and invisible natural gas which comes up out of the great natural gas reservoirs of the United States. Natural gas from the bowels of the earth has been burned for light and fuel in the gas fields of Pennsylvania, Ohio, Indiana and other States for the better part of two generations, but until comparatively recently it was not suspected that great quantities of gasoline could be extracted from it. The oil-well gas, known as casing-head gas, formerly went largely to waste. So the gas-gasoline which when blended for automotive use is purchased by the American motorist for over \$200,000,000 a year represents a distinct saving. There are two methods of getting the gasoline out of the gas; by compressing and condensing the gas and squeezing out the gasoline, and by absorbing or sucking it out of the gas.

The increase in production of gasoline from gas has been notable. Ten years ago the total output was seven million gallons; last year it was 400 million gallons, with a value of about \$75,000,000. This is, however, by no means the full economic value. Owing to the high specific gravity of this gasoline it is mixed with a low gravity, naphtha fraction of petroleum, at the rate of about two of naphtha for one of gasoline. So that last year there was produced for automobiles considerably over a billion gallons of "gas" which, except for these squeezing-sucking processes, would not have been on the market at all.

In 1904 probably the first gasoline from the gas of oil wells was made by A. Fasnemeyer, near Titusville, Pennsylvania. His crude plant is almost within sight of the old Drake well. That year he made 4000 gallons in this manner and received 10 cents a gallon for it. Tompsett Brothers, in the same region, claimed they had done the same thing even earlier. At any rate they are operating successfully at the present time. As these ventures proved successful other operators proceeded to install gasoline plants.

Casing-head gas is a "rich" or "wet" gas, and if it or natural gas contains as much as one gallon of gasoline to the 1000 cubic feet of gas it can be profitably treated by the compression or squeezing process. The dryer or "leaner" casing-head gas, more than half the amount produced, was not until recently stripped of its gasoline nor was any attention paid to a vast quantity of "dry" natural gas used for heating and lighting in cities and in factories. Yet all of this gas contains some gasoline. Now just at the time when gasoline has become about the dearest thing that automobilists have to buy, American inventive genius brings forth another kind of a process for treating this gas. This is known as the absorption or sucking process, and although the operation of a plant is a big as well as an intricate affair the principle is quite simple. After various experiments in trying to save the gasoline from this "lean" gas, G. N. Saybolt, at Hastings, W. Va., perfected an absorption process and built a good-sized plant which absorbed every particle of gasoline from the gas, leaving the

latter as "dry as a bone." The process economically sucks instead of squeezes the gasoline out of the natural gas where the content is even as low as a pint to the 1000 cubic feet. Certain oils, as we know, have the faculty of absorbing gasoline from natural gas, and the absorption process consists in spraying oil downward through long pipes or towers, at the same time forcing the gas upward. When the gas emerges at the top of the pipe it has lost all its gasoline, which has been absorbed by the descending oil. Then the gasoline is taken out of the oil by a simple process of distillation and the same oil does duty over again with another lot of gas. A good-sized absorption plant of this character will treat 80,000,000 cubic feet of gas a day. With one pint of gasoline extracted from each 1000 cubic feet of gas the output of such a plant is 8000 gallons of gasoline a day. A great deal of this "lean" gas, however, carries much more than a pint to the thousand cubic feet. These absorption plants have been or are now being erected in nearly all the natural gas fields. The removal of the gasoline, contrary to what one might think, does not reduce the value of the gas for domestic or factory use. It gives as good a light and as much heat. The processing is in fact a distinct advantage because if gasoline is left in the gas it destroys the rubber in the pipe couplings of the gas lines. The cost of replacing these rubbers, repairing broken connections and the resulting leakage of natural gas has been a large item of expense in the operating costs of gas line companies.

### Durability of Sole Leather Filled with Sulfite Cellulose Extract

**T**ECHNOLOGIC Paper No. 215 of the Bureau of Standards which may be bought from the Superintendent of Documents, Government Printing Office, at 5 cents per copy, describes the preparation of four lots of leather used to determine the comparative durability of sole leather filled with sulfite cellulose extract, and sole leather filled with ordinary vegetable tanning materials, such as chestnut wood and quebracho extracts.

Several hides were used in the preparation of each lot, and alternate sides were filled with the sulfite cellulose extract. Each pair of soles contained one sole prepared by each method, both of which were cut from the same hide, and from similar locations.

The results of actual service tests are presented which show that the average wear of the leather filled with sulfite cellulose extract was 9.08 days per unit thickness, and of the ordinary leather 9.06 days.

Complete chemical analyses of both the new and worn soles are also given. The general conclusions are that there is no difference in the two leathers as reflected by the chemical analyses, that sole leather filled with sulfite cellulose extract is as durable as leather filled with chestnut wood and quebracho extracts, and that the former could well be used in place of the latter materials, thereby conserving them for the actual tanning of leather for which they are more suitable than sulfite cellulose extract.



Upright absorbers at a large gas-gasoline plant



**S**WEATING is the secretion of a fluid, composed mainly of water, by certain glands in the skin. It takes place when we become subject to overheating, due either to high atmospheric temperature or to the rise in body temperature brought about by excessive muscular work. The function of sweating is to cool off the body through the evaporation of the water on the surface of the skin, the heat for the evaporation being absorbed from the body itself. The quantity of sweat that a human being can secrete under the condition of great physical labor or violent overheating is surprisingly great. This may amount to four liters in a few hours, which is a greater volume than the blood in the body. The human system must possess certain special functions for accomplishing this.

In the first place it has been found that the water that is removed from the blood during the process of sweating is replaced by the inflowing of a liquid, rich in albuminous substances, from the muscles into the blood current. And, moreover, more fluid is added to the blood in this manner than is lost through sweating, so that the quantity of blood becomes larger and the blood corpuscles are diluted.

Under the condition of long enduring or too violent sweating, as takes place when the sweat cannot be evaporated (as happens when we are taking a steam bath or are wearing a rubber raincoat), the water supply in the muscles becomes exhausted. No more water is removed from them and the immediate result is a thickening of the blood. The quantity of the blood becomes smaller and the blood corpuscles lie closer together than under ordinary conditions. Under these conditions we feel unable to perspire any more. There is then danger of a heat stroke.

The danger of the blood's thickening is particularly emphasized when the body does not contain sufficient salt, as may occur on long tramps, when the body has not a chance to replace the salt, lost in the sweat, by partaking of nourishment. The muscles can only yield up water in combination with salt, and as they must not lose their residual salt content, they similarly hold fast to the water. Consequently the condition, wherein the blood is thickened and the body is overheated, takes place so much the sooner, the less the supply of water and salt in the body.

When it is desired to dampen the heat of an oven it is possible either to increase the heat dissipation by hanging moist cloths around it, or to decrease the generation of heat by using less fuel in it. The same possibilities apply to the human system. Sweating corresponds to the first case. It is not so easy to apply the heat reduction process to living organisms. For the high temperature engendered in the body causes the chemical changes taking place therein to be effected at

## The Physiology of Sweating

a greater velocity with resulting formation of more heat.

Furthermore, sweating is an energy-consuming process as well, and is consequently productive of heat just as well as is muscular action. This is the reason why overheating of the body, once it is started, proceeds with such rapidity. It has generally been held that it is not possible to ward off threatened heat prostration by reduction or control of the generation of heat within the body. There is, however, a tendency to conserve substance in the overheating process, with resulting reduction in the combustion process. While this does not have a direct effect on the generation of heat, it nevertheless serves to equalize the energy consumed in sweating and the effect of the increased temperature on the chemical processes of combustion.

The ability to combat threatened heat prostration through reduction of the generation of heat within the body is better exemplified in certain animals than in man, who relies mainly upon the sweating process in this connection. It has been observed that the change in matter, that is, bodily chemical action, is less emphasized in the inhabitants of the tropics than in Europeans. Similarly after a person has been ill with fever for a long time it is customary to find the same condition. It is undoubtedly true that the reduction of the formation of heat within the body is a better weapon against heat prostration, where the battle must be drawn out for a considerable period of time; for it is longer lasting and independent of the humidity in the atmosphere, while sweating works better when the body is overheated for a short period of time and with an increased intensity.—From *die Umschau*, 1922, 139-140.

### Food for Brain Workers

**M**ANKIND has always been highly interested in the question of food from the practical viewpoint, but nowadays this empirical interest has been widened to include various scientific aspects of food in its relation to health and efficiency. For a long time we have been told that we eat too much meat. Indeed, there are various cults which restrict themselves entirely to vegetable diet, while others vary this merely by the addition of such animal food as milk and eggs. Very recently, however, two German professors have made the startling statement that while farmers and laborers in general can get along very well on cereals and other vegetable food, brain workers require a considerable amount of meat to keep them in health. The argument of these physicians, Dr. Knipping and Professor Kestner, which is quite plausible, is summarized in an article in a late number of *Reclam's Universum*.

They point out that brain work is always accompanied by a regular increase in the amount of phosphoric acid contained in the blood, and that this acidity must be got rid of as rapidly as possible. We read:

"While the manual laborer requires a greater amount of food with a large content of carbohydrates to secure a high degree of efficiency, the brain worker, on the other hand, suffers an excess of acidity in the blood due to the large amount of phosphorus contained in the brain substance; this acidity has ill effects and must, therefore, be counteracted in some manner. The best way of accomplishing this is to increase the flow of the gastric juice. Hence the intellectual workman requires a food which will stimulate the secretion of the gastric juice, particularly. Mere increase in the amount of food taken is not sufficient.

"Among the usual forms of food, meat is that which stimulates most strongly and for the longest time this secretion of the gastric juice. Hence brain workers should eat plentifully of meat and should receive payment at a rate which would make this possible." . . . Professor Kestner makes some interesting remarks as to the value of meat as a vehicle of nutrition. He remarks that every one needs for the support of life a definite amount of food which varies according to the amount of work done, since the greater the amount of work the greater the number of calories required. These calories can be supplied by purely vegetable matter. But all persons require likewise a constant amount of albumen, no matter how much or how little they work, and no matter how large the total amount of food taken. This necessary minimum of albumen or protein is approximately 100 grams per day. The manual laborer can readily obtain this minimum, even upon a purely vegetable diet—from bread, for example. But the brain worker who requires a much less total amount of food is unable to obtain this 100 grams of albumen merely from bread and vegetables.

The conclusion drawn by these physiologists is that those persons who do heavy muscular labor can get along entirely without meat in the diet, but that those who work at desk or counter where the muscles are called on for less and the brain cells for more must look to meat not only as the most important source of the necessary albumen, but also as the most valuable means of remedying the excess acidity of the blood, by the stimulation of the gastric juice secretion. They even go a step further and claim that to civilized men living in cities meat is almost indispensable.

The absence of meat from the diet of certain Orientals is reflected in their general make-up. Their meatless diet seems to make them thinner than the meat-eating races, but far harder and more alert. Too much meat makes for a heavier, healthier looking physique, but certainly less hardy and less alert mentally.

**D**RAWING a line between the theoretical and the practical, there is danger of assigning too little value to the theoretical. Though of no present practical import, often within a surprisingly short time the theoretical becomes intensely practical. Such has been the case with electro-osmosis. Originally a most abstruse process, this is today fast being developed commercially in Germany, with interesting and important results.

When an aqueous solution of a mineral salt is filled into a vessel which is divided into two compartments by a porous diaphragm, on passage of an electric current the water is carried through the wall; and the level of the liquid is raised on one side and lowered on the other. Not unrelated is the migration of solid particles to the anode or cathode, when instead of actual solution we have mere suspension of solid particles in the water through which the current passes.

We have no space for any of the intimate details of this phenomenon. The choice of the diaphragm is of vital importance; more than this we cannot say. But we can and shall give a brief review of the applications of this highly complex chemical process.

One of the best examples of these is in the tanning of leather. The green hide itself acts as diaphragm. By osmosis the tanning solutions pass into and through the hide, and the tanning is effected in a greatly shortened time. With sacrifices of this advantage, extremely dilute tanning solutions may be used with effect.

Sterilization and preservation of food and fodder by electro-osmosis has passed the experimental stage. Milk, for instance, with high bacterial content, is filled into the middle compartment of a vessel having three sections. A little brine is added to increase conductivity, and the current allowed to flow through the

## Electro-Chemistry in New Fields

milk. After the treatment, the milk is found to be free of bacteria. The same process has been used with brewing wort; with a mash of ground beef which had spoiled; with spoiled eggs that had taken up the boric acid with which they had originally been treated. In every case the sterilization was successful; in every case it is entirely distinct from ordinary sterilization by chemical means. Nothing is added; simply the bacteria are removed. There are now sixteen plants in Germany where this process is employed.

The albuminous carrier of serums and antitoxins is apt to get contaminated with all sorts of extraneous bacteria and decomposition products. By electro-osmosis it is simple to prepare a serum which shall contain only the gelatine support and the active antitoxin, without contamination. By similar means, the nicotine may be extracted from tobacco without affecting it in any other way. Similarly, the bitter principles may be removed from various vegetable products.

For pottery and other purposes clay and kaolin must be had in the finest possible state of subdivision. Electro-osmotic action is now available to precipitate the coarse particles of the clay and leave behind a highly colloidal mass, which may then be dehydrated in a colloidal filter-press.

Again, machines have been devised wherewith it is possible to utilize the osmotic action directly in the manufacture of pottery, by causing the deposition of the fine clay particles on the walls of the molds, and then allowing the current to remove the water from the clay. The thickness of such deposits is easily regulated. Similarly, a fine deposit of kaolin may be induced upon a metal wire, which may then be used as the base of artificial silk.

The gelatine of photographic emulsions must be as pure as possible. There is no process known that will produce so pure a gelatine or glue as electro-osmosis. The

passage of the current through the gelatine removes all mineral salts, and leaves an ashless gelatine. As well, all albuminous or fatty substances and all decomposition products are removed.

Electro-osmosis is adaptable to the sugar industry, where with proper technical skill the current may be made to eliminate all mineral salts from the molasses and other sugar groups. This done, the ordinary decolorizing action of lampblack is greatly increased.

There are many other possibilities. Electro-osmosis is used in the preparation of crude gelatine for pharmaceutical purposes and for use in the manufacture of nitroglycerine. It is used in the removal of the water contained in dye pastes. It is used in the treatment of poles, ties and piles of wood, for rendering these more resistant to the influence of weather and water; in this instance the sap is driven out of the wood by the osmotic action, and preservative fluids substituted. It is used in the purification of viscose and other cellulose products such as nitro-cellulose and cellulose acetate; in the treatment of vegetable fiber in conjunction with chemicals for paper-making; in the recovery of the soda contained in cellulose liquors.

These applications of electro-osmosis have demonstrated that this particular property of the electric current can be utilized to good advantage in various chemical and allied industries. It forms one of the new developments that are taking place in chemical enterprise, wherein other forces are being used to promote chemical action, than the ordinary ones of heat, light, etc. The fact that electricity can be used to bring about effects, which are really seemingly impossible in certain cases and often unattainable by other means has now been recognized.

# Taking the Kinks Out of Our Rivers

## How We Can, and Why We Should, Make Our Streams Better Behave Themselves

By Ivan E. Houk

City Engineer, Dayton, Ohio

**M**ANY river towns, especially those located on the smaller streams, could add to their appearances as well as to their safety from flood damage, by improving their river channels. Comparatively few river municipalities throughout this country have made adequate river improvements although some have comprehensive plans well under way. Erie, Pa., has taken care of her flood problem. Columbus, Ohio, is just finishing some river channel improvements. Harrisburg, Pa., has built beautiful parks and boulevards along the banks of the Susquehanna. Dayton, Hamilton, Miamisburg and other Miami Valley towns in southwestern Ohio are now completing their river improvements, the work being done by the Miami Conservancy District, a political subdivision of the State of Ohio created for the purpose of designing and constructing flood prevention works. Dayton plans to develop an elaborate system of parks along the river front on the lands built up by fill from the channel excavation, lands which prior to the flood prevention movement were either city dumps or waste river bottoms. Pueblo, Colo.; Dallas, Tex., and various other cities have river improvement work either under way or under serious consideration. Yet the total number of municipalities which have tackled the flood problem is small compared with the number that should do so.

The necessity for improving river channels, from the standpoint of flood protection, came about gradually with the development of the river towns. Years ago, when our cities were first settled, the people built along the river front in order to be close to the means of transportation. In those days flat-boats, barges, canoes, and so forth, constituted the only methods of marketing the produce. In order to be safe from floods the people naturally built their homes and stores where the banks were high, sometimes building small levees along the river to increase their safety. The low lands in the bottom of the valley, outside the main channel, were left in their natural condition, unoccupied, for a time, and consequently served as auxiliary channels during flood periods. Eventually, however, as the town developed, the low lands were filled in and built upon, thus shutting off from use these additional flow areas and backing the flood waters higher and higher. For the smaller floods this increased height of water surface, though appreciable, was not serious. It was not until the arrival of the comparatively great flood, the flood that comes once or twice in a century, that the people realized what they had done. Dayton did not realize the inadequacy of her river channel before the great flood of March, 1913. Pueblo did not realize she had obstructed the channel of the Arkansas River until the flood of June, 1921, arrived. Many cities today are resting in apparent security when in reality they are in as serious a condition as regards possible flood damage as was Dayton in 1912, or Pueblo in 1920. Think how many lives might be saved, how much property damage might be avoided, if the people could only be made to realize now the seriousness of their situation and could be persuaded to proceed at once with the necessary improvements. Over four hundred lives and more than a hundred million dollars worth of property would have been saved in the Miami Valley alone if the people there had built flood protection works before the flood of 1913 instead of afterwards.

In general the flood-carrying capacity of river channels may be increased by deepening, widening, straightening, building levees, smoothing the banks and bed,

*RIVERS and towns go together; it is a rare municipality indeed that is not built beside a stream of some proportions. And rivers have a lot of habits which are quite harmless so long as they flow through open country or through forests, but that become highly objectionable when applied to docks and city streets and back yards and railroad sidings. Mr. Houk, speaking from a wide experience in making rivers behave, tells us here in simple terms what the problem involves, and how it may be met.—THE EDITOR.*

removing vegetation and debris, enlarging bridges, and so forth. Sometimes it is even necessary to fill in parts of the channel, since a channel of uniform size carries water better than one having an alternately increasing and decreasing area of flow section. Smooth iron pipe

withstanding the fact that flood prevention dams comprise the major portion of the improvements. While the official flood protection plans for Pueblo, Colo., have not been fully approved, it appears that channel improvements for that city will consist primarily of widening. The plans for Dallas, Tex., calls for levee construction with some cleaning and smoothing of the channel bed. The lower Mississippi River works have consisted almost wholly of levee construction; and despite the criticism of Sir William Wilcocks, made at the time of his visit to America a few years ago, they are efficiently and adequately serving the purpose for which they were intended and are without doubt the proper solution of the problem.

Removing vegetation and debris from river channels and smoothing the banks and bed serves to better the appearance of the channel as well as to increase its flood carrying capacity. Probably the former benefit is more important than the latter, especially in the case of the larger streams. Any city can well afford to keep its river channel clean whether or not the cleaning is necessary from the standpoint of flood capacity. As a matter of fact if the capacity of the channel is much too small, as it formerly was at Dayton, cleaning out the vegetation and debris and smoothing

the bed and banks will not be sufficient to provide the additional capacity required. Removing all vegetation and debris from the channel of the Miami River at Dayton at a time when weeds as high as a man's head covered about two-thirds of the wetted perimeter had the effect of lowering the water surface 1.3 feet during a flood of about 23,000 second feet. During larger floods the effect would be less, whereas an actual lowering of about nine feet was required during maximum floods in order to keep the water between the levees. By far the greater part of the nine-foot reduction has been obtained by constructing

detention basins above the city. The remainder has been secured by deepening the channel, smoothing the banks and bed, and eliminating irregularities in area of cross section by filling in outer portions of the larger sections with material excavated in deepening the channel.

Straightening river channels reduces the distance the flood must travel and consequently increases the available hydraulic slope, thereby increasing the mean velocity. This is the principal effect of straightening. Of course there is also some increase in hydraulic slope due to the fact that water can flow through a straight channel easier than through a crooked one. However, this effect is much less important than has generally been accorded. Experiments during actual floods at Dayton showed that the difference between the head required to carry an average annual flood through a given length of straight channel and that required to carry the same quantity around a 90-degree bend of the same length, could hardly be measured; whereas calculations by formulas previously recommended for such curves indicated that at least a half a foot would be required. Apparently the additional head required at bends is consumed in the transition sections at the ends, where the conditions of flow must be readjusted from the straight channel to the curved, and vice versa.

In flowing around a bend the water surface at the outer bank is higher than at the inner bank, in accordance with the laws of centrifugal force. In fact the difference in elevation can be calculated by the formula

$$E = \frac{V^2 B}{g R}$$

developed from the laws of centrifugal force,



In the Dayton channel improvement work drag-lines were mounted on scows and floated from place to place. Scows were also used to convey the excavated material to the spoil bank, a small steamboat furnishing the necessary motive power

has been found to carry more than twice as much water as corrugated pipe of the same size under the same hydraulic conditions.

Practically all of the above noted methods were involved to some extent in the Miami Valley works, not



Laying concrete block mattress along the river channel at Dayton, the blocks being tied together by half-inch galvanized steel cables



where  $V$  is the mean velocity of the water,  $B$  the width of the channel,  $g$  the force of gravity, and  $R$  the radius of curvature. Measurements during flood periods at Dayton checked this formula almost exactly.

Enlarging the area of the channel cross section by deepening or widening, or both, is one of the best means of increasing the flood-carrying capacity, since the quantity of water the channel can carry is a direct function of the area. Deepening the channel has a relatively greater effect than widening since deepening increases the mean velocity in the entire cross section as well as increasing the area of the flow space. The deeper the channel the greater the Chezy coefficient as well as the hydraulic radius; and it must be remembered that in the Chezy formula, the standard equation used by engineers for computing flow in channels,  $V = C\sqrt{RS}$ , where  $V$  is the velocity,  $C$  a coefficient depending on the smoothness of the channel,  $R$  the hydraulic radius, area divided by wetted perimeter, and  $S$  the friction slope, the velocity increases directly as  $C$  and as the square root of  $R$ . However, in some cases widening is more practicable than deepening, since deepening may increase the channel velocities beyond the safe values.

Mean velocities in natural earth or gravel channels should never be allowed to exceed 10 feet per second unless some provision is made for preventing scour. Even with such velocities, it is advisable to line the banks at ends and other critical places with concrete, riprap, slag, or some similar substance. In the Miami Valley channel improvements a flexible concrete mattress, made of concrete blocks 24 inches long, 12 inches wide, and 5 inches thick, tied together with  $\frac{1}{2}$ -inch galvanized steel cables, has proven very satisfactory along the lower portions of the banks where scour is most likely to occur. When the edges of the mattress are undermined the blocks simply settle down, filling up the depression and thus adjusting themselves to the shifting conditions. The levee slopes above the block are protected by concrete slabs, 6 inches thick, 8 feet wide, and of variable length depending on the height of the maximum flood. At Pueblo, Colo., slag from the steel mills has given satisfactory slope protection.

The one unfortunate disadvantage of channel enlargement by deepening and widening is that it is not permanent unless kept so by proper maintenance. Rivers flowing through alluvial lands have a tendency to keep shifting their course. Their channels are made up of pools and bars. If the bars are all removed the river at once sets at work to restore them. If the channel is excavated to more than average depth in a particular length the current brings down gravel from above to fill up the hole. If a channel is excavated to the size required to carry the maximum possible flood and then left to itself for a time it will not be in shape to do the work required of it when the flood arrives,



Excavated material from the river channel may be used to fill the low lands, thus converting waste areas into valuable building sites

Consequently any plan for improving a river channel by deepening and widening must also provide for adequate maintenance.

Building levees produces essentially the same results as deepening the channel, but does not require nearly so much maintenance. The only difference between river improvement by levee construction and by channel deepening is that the increased depth and area are obtained by raising the water surface instead of by lowering the bottom of the channel. Of course the best, and most usual, method is to excavate the material needed to build the levee from the river bottom, thus securing a greater channel capacity for the same stage

fact that such methods cause serious interference with existing structures, as for instance, bridges, street grades, sewer outlets, and so forth.

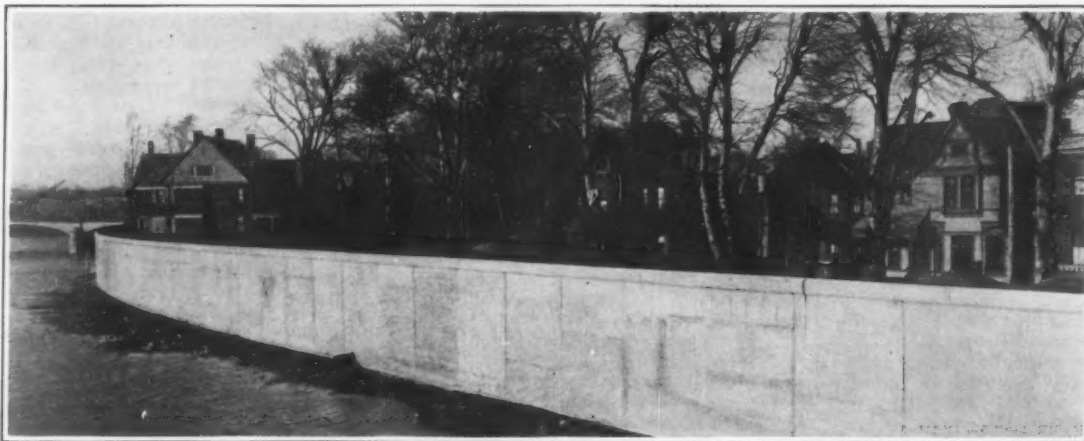
The hydraulic design of bridge openings should receive careful consideration in any river improvement project. As a general rule too little attention is given to the hydraulic conditions when the bridge is designed. Municipal engineers, as well as the laity, have a tendency to underestimate the effect of the bridge on flood flow before the flood arrives and to overestimate the effect after the flood has passed. After the Dayton flood had receded at least 95 per cent of the people knew that the disastrous conditions were due entirely

to the bridges, whereas the facts of the case are that if there had been no bridges at all in the entire valley the damage would not have been one per cent less than it actually was. However, the Dayton situation cannot be taken as representative in this respect. There are many places where the backing up caused by bridges results in serious damage.

The net area of the bridge waterway below the high-water line should be the same as the cross sectional area of the channel above and below the bridge, measured up to the same elevation. The best

way to obtain this condition is to deepen the channel under the bridge enough to compensate for the cross sectional area occupied by the piers and abutments. There is no necessity whatever for making the bridge waterway larger than the channel; but it should always be made as nearly equal to the channel as possible. Bridge piers should be rounded at both ends and their sides should be as nearly as possible parallel to the direction of the current. If the waterway under the bridge is not as large as the channel above and below there will be a backing up of the water above the bridge in order to increase the velocity through the opening; and the height reached will depend on the amount of the contraction. However, not all of this head is lost.

Channel excavations and levee construction may be made in various ways. Draglines, steam shovels, clam-shell dredges, suction dredges, dipper dredges, teams and scrapers, have all been used. The most economical method in a particular city, of course, depends on the local conditions. Draglines have been used almost exclusively in the Miami Valley. At Dayton the draglines were mounted on scows and floated up and down the river to the desired locations. The excavated earth was also loaded on scows and hauled away to the dump by a steamboat, where it was unloaded by another dragline. A small temporary dam built across the river raised the water high enough to float the equipment. At Hamilton the draglines worked up and down the river bottom loading the excavated material on cars brought to the machines on temporary railroad tracks. In the latter city an area of low waste land, nine blocks long and several hundred feet wide, was filled with excavated material from the river channel, and thus converted into valuable building sites.



A smooth concrete wall along the edge of the river adds much to the appearance of the channel—and to its durability as well

as well as making the channel safe for higher stages. If there are no complicating factors involved levee construction is less costly than channel deepening, especially in the case of the larger rivers. If the stream is comparatively wide levee construction will require less earthwork than channel excavation. Two levees, each 20 feet wide on top, 5 feet high, and built with side slopes of 1 to 1, will require only half as much earth as must be excavated in order to lower a channel bottom 5 feet across a width of 100 feet. Of course the levees must be built somewhat higher than the ultimate high-water mark in order to provide adequate freeboard. The difficulty of securing adequate flood protection by levee construction in many cities is the



A flexible mattress of concrete blocks, which settles into the depressions scoured out along its inner edge, and prevents the scour from reaching the slope pavement on the levee

## Twelve Reviewing the Outstand

## Months of Radio ing Features of the Remarkable Radio Year 1922

By John Liston

**N**O MATTER what may be the radio developments of the future, which must perforce belittle the achievements of today, it is certain that the year

1922 will stand out in the history of radio. For it was during the past year that radio broadcasting became a regular feature of every-day life, and radio entered the average home life of the average man. Then, too, this popular interest stimulated radio progress as never before, with the result that remarkable engineering achievements took place.

Continuing our survey of past performances, the line of standardized radio parts which had been originally designed for commercial purposes was later produced for the amateur. Broadcasting receivers were built, making use of these parts; and a line of sectional units, such as the tuning unit, the three-stage radio-frequency amplifier unit, and the detector-amplifier unit, was developed. The main idea in these sets was the production of receivers, each of which would serve a definite function separately, and could also be easily combined.

The general tendency in receiving tubes was toward the reduction of the power consumption in the tube filaments. The first attempt resulted in a detector and amplifier tube using one-quarter ampere in the filament, superseding one previously using one ampere. Later a tube using only 60 milliamperes for the filament was equally successful.

These new tubes made it possible to use dry cells for the filament excitation, and two new receivers were produced. One, a portable set, contains a sensitive tuning system, a detector, and single-stage audio-frequency amplifier. The other set is similar in its electrical characteristics to the first one, except that it has two stages of audio-frequency amplification instead of one.

In the line of commercial equipments new requirements were met, due in many cases to broadcasting. In one case a power company sought a duplex radio telephone installation with which it could provide, during times of storm, against possible interruption of communication between several of its stations 75 miles apart. At the same time signals from nearby broadcasting stations operating on 360 meters were not to interfere with operation of this station on the only available wave-length of 400 meters. The set was to be operated through remote control from a desk-stand by the regular power-house switchboard operators and to require no attention except that usually given to such moving parts as motors and generators. This set was designed and installed and is operating successfully.

For the use of amateurs and for installation on small boats and yachts there was produced a small radio telephone transmitter having an output of 20 watts in the antenna. It is built so that it can be operated either from a motor-generator set or from a kenotron rectifier which was designed for this equipment. It can also be used as a telegraph transmitter for sending either continuous wave or interrupted continuous wave signals.

A new tube attachment for converting spark transmitters into vacuum tube continuous wave transmitters makes it possible for owners of spark sets to realize the advantages of continuous wave transmission at a minimum cost. It has an output in the antenna of approximately one-half kilowatt continuous wave and a wave-length range of from 2000 to 2400 meters. It utilizes the power equipment and high potential transformer of the spark transmitter, and includes necessary switching apparatus so that communication can be transferred from the spark set to the tube attachment. This equipment makes it possible not only to carry on communication with stations now listening-in on 2200 meters, but to carry on communication over much greater range with a two-kilowatt spark transmitter. During actual service tests conducted with one of these



Prof. Morecroft, well-known radio worker, holding latest 20-kilowatt water-cooled tube (right) and one-half-kilowatt round British tube

transmitters a range of 1500 miles daylight, over water, was realized.

An aircraft transmitter was constructed for telegraph communication only with a continuous wave output in the antenna of 300 watts. Provision was also made for interrupted continuous wave telegraphy. The transmitter was designed to operate from a double current stream-line generator driven by an automatic speed-regulating propeller.

A number of telephone and telegraph transmitters were built for installation on submarines of the U. S. Navy, which include many novel features of construction and operation. They are designed for transmitting either on the flat-top antenna or a loop, and include a break-in system whereby the operator can

listen-in between dots and dashes of the transmitted message; they are available for three methods of communication and have an output of 600 meters continuous wave in the antenna. The complete equipment was extremely restricted in dimensions on account of the service for which it was built.

New apparatus designed and manufactured for use with 200-kilowatt Alexanderson alternator equipments consisted of antenna tuning inductances, remotely controlled antenna wave-change switches and remotely controlled antenna variometers. One of the antenna tuning inductances designed for outdoor service installed at Radio Central Station has a coil composed of ten vertical supports on 82-inch diameter centers. These supports are of porcelain tubing, of 3 1/2-inch outside diameter, and are held semi-rigidly by copper rings on the inside of the vertical tubes. Attached to each of the ten vertical supports are fourteen spacing blocks which are so designed as to provide a maximum surface-creepage-distance between turns. The conductor, which is wound in grooves of the spacing blocks, is of 686 strands of 10-mil diameter copper wire, each strand insulated with enamel. Varnished cambric and treated braid on the outside provide insulation and protect the conductor from the weather. The

are to be mounted adjacent to the tuning inductance described above, and will be used to change the number of active turns in the inductances. Ten of these switches were furnished with the two alternator equipments for the Polish station. They will be located at various distances up to more than a mile from the generating station, the point from which they are to be controlled.

In the operation of remotely controlled antenna variometers for indoor service, means for remote control from switchboard and hand control at the variometer were provided. These variometers are connected in series with 200-kilowatt Alexanderson alternators, feeding energy to multiple tuned antennae. They are used to maintain close adjustment of antenna tuning, particularly when antenna capacity is varied by wind and sleet. Porcelain supports are used throughout for all parts connected in circuit and the conductor is composed of 4270 strands of 5-mil copper wire, each strand insulated with enamel. Varnished cambric and treated braid form the outside insulation.

Due to the high-intensity high-frequency electro-magnetic field produced by the windings, no metals of any kind are used inside the windings. The top supports of the framework are of brass. Iron pipes attained high temperatures at fractional load in the windings. Closed circuits in the pipe framework are broken up by suitable insulators to prevent circulating currents. The stationary and movable windings may be connected in series or parallel. The average range of inductance in series connection is .19 to 1.1 millihenries. Maximum coupling averages 50 per cent.

Somewhat aside from pure radio, but nevertheless bound up with radio progress, is the new method of recording and reproducing sound developed during the past year. This method is a distinct improvement in many ways over all previous methods used, and opens up several entirely new fields of amplification. It is known as the Pallophotophone, and there are two distinct devices involved, one for recording and one for reproducing the sound. Either may be used independently.

The recording device of the Pallophotophone consists essentially of a tiny mirror on which is reflected a beam of light. This mirror is attached to a delicately vibrating diaphragm, and when sound waves cause the diaphragm to vibrate, the mirror oscillates and the ray of light causes projection of corresponding oscillations upon a strip of photographic film which passes in front of the mirror in a continuous motion. The film is then developed in the usual way and shows a succession of delicate dark markings which constitute the sound record.

In the reproducer device, the film passes in front of an arrangement of photo-electric cells which are sensitive to light, so that the variations in the light falling on them caused by the lines recorded on the film, produce electro-motive force variations in the circuit in which they are connected. Therefore, as the film is moved in this device, the electric current is actuated, which corresponds with great accuracy to the original sound wave. This electric current can be made to actuate a telephone loud-speaker or to operate radio broadcasting apparatus directly. Many interesting applications of this new device have already been made and a few possibilities can be briefly outlined as follows:

It makes possible the talking motion picture, for on a film of the normal width, both sound and action can be recorded simultaneously and projected with absolute synchronism. It is practically unlimited as to the length of record it can make and reproduce and is, therefore, suitable for recording speeches, debates

(Continued on page 286)



Perforating a paper ribbon preparatory to the automatic transmission of transatlantic radio messages at 120 words per minute

total inductance of such a coil is 19 millihenries.

Ten of these coils were furnished with two 200-kilowatt alternator equipments for the new radio station near Warsaw, Poland, which is being built by the Radio Corporation of America.

Material for four coils of the same general design, except that six vertical supports on 65-inch diameter centers are used, is being furnished for the Radio Corporation's station near Bolinas, Calif.

Remotely controlled antenna wave-change switches



### Our Army's Helicopter

THE United States Army Air Service now announces that at last it has developed a helicopter, or winged screw type of flying machine, of the successful variety. During the closing days of the past year a successful flight was made at the headquarters of the Engineering Division at McCook Field, Dayton, Ohio. The duration of this flight was one minute and forty-two seconds, during which the machine attained a height of six feet. The helicopter rose straight from the ground and was maneuvered at the will of the pilot, finally descending and landing safely. It is reported that the flight was steady and gave every assurance that the machine would perform satisfactorily at greater heights and would maintain remarkable stability in actual flight.

The present helicopter, which has been built by the U. S. Army Service, has been designed by Dr. G. de Bothezat, an aeronautical engineer of note, and was constructed under his direct supervision. Work was started in July, 1921, but no publicity was given to the undertaking until the initial trial flight.

The de Bothezat helicopter has a total weight of 3000 pounds, including the pilot and the full fuel supply. The upward lifting power is obtained by means of four horizontal screws of the de Bothezat plane-radial type, actuated by a Le Rhone motor of 170 horsepower. A novel system of gear drive is employed.

### Variable Surface Wings for Variable Speed Airplanes

THE accompanying photographs illustrate the latest improved method of causing an airplane to take off and alight at slow speed, while at the same time making it possible for the airplane to maintain the maximum speed in flight. The manner in which this extreme difference in speed is accomplished is by varying the surface of the wings or planes of the biplane by withdrawing the rear part of the wings from the front part to increase the surface, and sliding the rear part back into the front part, into which it telescopes, when the airplane is in flight and it is desired to attain the maximum speed.

The altering of the surface of the wings is accomplished by the aviator turning a crank within the body, which he can do very readily, thus gradually increasing the speed. With the wings withdrawn to the full extent, the chord, or distance from front to back, is increased materially as is also the curvature. By increasing both the chord and the curvature, a very great lift is obtained at slow speed in starting and landing, while conversely, by shortening the chord and reducing the curvature in flight, something over 20 per cent is added to the speed that a normal machine with non-variable wings would have in flight.

This new improvement in airplane construction is the invention of a Frenchman, M. Billé, and it seems to be a far neater and better solution of the problem of reducing landing speed while at the same time attaining the maximum speed in flight, than that of the variable angle of incidence devised by the Hollander-Lanzus, or even that of the slotted wing invented contemporaneously, practically, by Mr. Handley-Page and by Herr Lachmann.

Wings of this type will



With all wheels off the ground: Successful flight of the de Bothezat helicopter constructed by the U. S. Army Air Service

mean much to the development of commercial airplanes, since they can be made to carry very much greater loads at considerably increased speeds and with safety.

### Something New in Tandem Airplane Design

THERE has recently been completed in France a huge airplane of which little is being said. In fact, while the accompanying startling photograph of the machine has been released for publication, little or no details are given to the press, for the present, at least.



Aside from the huge dimensions of this new French plane, it is unusual for its queer positioning of the four sets of wings

The huge airplane has four sets of planes or wings, arranged in a staggered tandem arrangement. A pair of wings form the usual biplane arrangement, while another pair, dropped half way down and a short distance back of the first pair, complete the supporting surfaces, as shown. Just what are the advantages of such an arrangement, we cannot say at present, although from the successful trial flights it appears that the wings are serving satisfactorily despite their unorthodox positioning.

Four engines, each of 270 horsepower, drive the huge

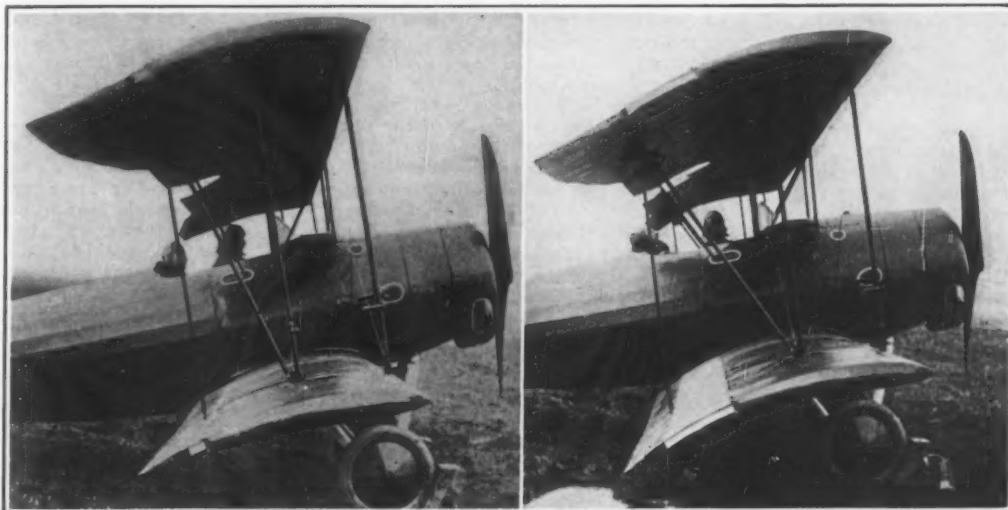
sires, volitions, and the like, which, though simplified in form, were nevertheless the same as those in ourselves. But this so-called anthropomorphic viewpoint was soon found to present many difficulties, some of which turned upon new discoveries concerning man himself. It was becoming apparent gradually that human beings, in addition to their ordinary mental life, possess a multitude of nervous activities, some of which are subconscious and many of which have no direct relation whatever with consciousness. Thus the heart, the blood vessels, the digestive tube and other parts, all of which possess their own nervous equipment, exhibit a range of operations of a highly complex and responsive kind that may be entirely dissociated from our conscious states. As these operations are directed toward the successful continuance of life of the individual in which they occur, we are forced to ask the question, May they not afford an example of the kind of nervous life led by many lower animals whose whole nervous equipment may then be as devoid of the so-called higher nervous states as our heart or our intestines are?

One of the newer lines of evidence touching on this point has to do with sense organs. These organs are usually regarded as bodily parts concerned with providing us with the elements of information as to the world about us. They are thus intimately associated with our central nervous activities. But they are known to occur in many lowly organized animals, such as the jellyfishes and the like, in which there are no central nervous organs appropriate for such information. In these animals the nervous impulses from the so-called sense organs pass directly to the muscles without first making their way through a central nervous organ. They serve merely as a means of exciting muscular activity and are concerned in no way at all, so far as one can judge, with sensations.

To the older naturalists the presence of a sense organ was sufficient grounds for assuming that the animal experienced sensations characteristic of that organ. Thus the recognition of eye spots in jellyfishes was supposed to justify the opinion that these queer animals could see.

However, from the standpoint of the more recent work the presence of such an organ merely means that the animal is especially responsive to light, not that it has the sensations of sight, for the nervous strands from the eye spot in the jellyfish lead directly to the muscles and not to a central nervous organ.

Hence we gather that the so-called sense organs of the lower animals, since they are in no necessary way concerned with sensations, are more correctly designated as receptors in consequence of their relation to the stimulus.—Abstract from article by G. H. Parker in the *Proceedings of the American Philosophical Society for September, 1922.*



The telescoping sections of this airplane wing is said to facilitate starting and to make for greater speed when in flight

# Irrigation in Australia

## The Murrumbidgee Project, with Storage Capacity for 200 Billion Gallons

By P. J. Risdon

**I**N MANY countries there is no greater or more important problem than that of irrigation and water supply. Some that are fairly well watered by rivers at certain seasons are left dry and parched at other times. The vast areas served by the Nile are a good and familiar instance for, until the construction of the Assouan dam (resulting with other works in the irrigation of 6,000,000 acres), for conserving a proportion of the river waters against the dry seasons, vast quantities of water ran, one may say, almost to waste during the times when the river was in flood.

India, where some 60,000,000 acres are now irrigated, has of course for many years been a veritable training ground for irrigation engineers, and in other countries the necessity for providing means for storing the natural supply of water for use during drought has been recognized and the necessary works have been undertaken, with the result that, not only has a good supply of water been made available throughout the year for general commercial and domestic use, but in agricultural districts, for every crop grown before, several crops have become possible.

In countries where such conditions obtain, there are two principal methods of ensuring a constant water supply. One is by means of aqueducts, of which system the Romans were masters, or pipe lines such as are now often employed either alone or in conjunction with aqueducts. Pipe lines that convey water from springs on the slopes of the Andes to waterless districts on the Chilean coast—a distance of 250 miles—are an instance.

The other method consists of damming lakes and rivers and by means of valves or sluices controlling their flow. Sometimes the two systems are combined, as in the case of the Birmingham and Liverpool water supplies.

It is not a little strange that Australia, with vast, unwatered or poorly watered tracts of country, should have been notably behind hand in taking the problem of irrigation seriously in hand. The appalling losses to farmers in sheep and in various ways, as the result of terrible drought, are but too well known. One can only assume that the magnitude of the problem, and the fact that in some parts there seems little or no chance of bettering the conditions, are responsible for the lack of initiative in the past.

Nevertheless, as our illustrations show, it was at last tackled on a splendid scale by the construction of the Burrinjuck reservoir and other works in connection with it in New South Wales. This work comprised the construction of a dam no less than 236 feet high across the Murrumbidgee River—one of the big rivers of Australia. Rising in the mountains the river pursues a winding course for about 700 miles to its confluence with the Murray River. A curious feature of the Murrumbidgee, in common with other tributaries of the Murray, is that, after reaching the plains, instead of its volume increasing in the orthodox manner, it actually decreases. This is doubtless due to its sluggish nature and the fact that it tends to spread out into wide lagoons, so that a great deal of its water is lost by evaporation and percolation.

One of the difficulties, common to all such undertakings, is to select a suitable site for a dam. Such selection is generally a matter of compromise. It may happen that from one point of view the most desirable position would entail too costly a structure, whilst one

where minimum cost would be entailed may be almost useless. Consideration has to be given not only to the length of the river and the area and nature of the land below the dam which will have to be supplied from the reservoir in dry seasons, but to the quantity of water which will be available for storage. Again, the fall of the river above and below the projected dam, the nature of the country and the rainfall have to be studied for scores of miles above the site, in order to make certain of imprisoning an adequate quantity without undue escape and loss of water.

In the case of the Burrinjuck dam an almost ideal site was selected about 200 miles from the source, where the river passes through a deep and narrow gorge of granite rock, the catchment area above the site consisting principally of hard shale and comprising some 5000 square miles. The river, like many others, owes its origin partly to melted snow from the mountains, but, in addition, the rainfall in the catchment area is heavy, amounting in places to between 60 and 70 inches annually. In times of flood the water sweeps through "byewashes" or channels formed be-

1200 tons per foot of the length. Some 20 square miles of water are retained by it, equaling 766,300 acres one foot deep at a capital cost of £1 per acre foot impounded. The holding up of this great quantity of water affects the river level for a distance of 40 miles above the dam.

In many tropical and sub-tropical countries, the carrying of roads and railways across rivers presents a serious problem. The width and height of bridges have to be proportioned for the worst floods, so that a bridge may easily cost five times what it would had it only to span the river in its normal condition. This happened in the case of several bridges over the Murrumbidgee River, and a curious result of the construction of the dam is that, by controlling it and maintaining a more or less average flow, several big bridges exist lower down the river that would serve their purpose equally well now if they were less than a third of their length.

Owing to the altitude of the reservoir and its height above the country to be served by it, it was necessary to make further provision for the economical distribu-

tion of water, so that the dam and reservoir alone may be regarded simply as a means for controlling the flow of the river. At a distance of 220 miles below the reservoir, a weir 270 feet long was constructed upon a natural bar of granite that stretched across the river at a most convenient spot. At this point the river is about 500 feet above sea level, that height being sufficient to control ultimately the irrigation of 6½ million acres of land—about twice as much as the catchment area of country drained by the river above the dam. Great engineering feat as it is, the cost of the dam (about £760,000) represents less than half the expenditure on the whole scheme. The weir is provided with regulators for controlling the flow and in it a lock 40 feet wide is provided for passing boats 100 feet long. The regulators have a lift of 35 feet, sufficient to clear the highest recorded flood level. The river sometimes rises so suddenly that what was merely a stream may become a raging torrent within 24 hours. As it happens, it takes about that time for

the water to travel from the dam to the weir, and as the two stations are in telephonic communication, the engineers at the weir are sure of 24 hours' notice of an oncoming flood so that they may be in readiness for it.

From the river above the weir a great main irrigation canal, 100 miles long, 64 feet wide and 8 feet deep, forms part of the scheme. Through this canal flow 1000 cubic feet of water per second, for irrigation purposes. At intervals, branch canals and subsidiary channels are cut so that every farmer may, at a cost of 5 shillings per acre-foot of water, obtain through a meter the supply needed on his land.

Through the bottom of the dam, 200 feet below water level in the reservoir, is the tunnel-like aperture through which a great proportion of the water of the Murrumbidgee river is directed. This aperture measures 14 feet 3 inches by 13 feet and extends from the upper to the lower side of the 168 feet thick base. At each end are big regulator valves, operated through gearing from a machinery tower, for controlling the flow. Below the top is a smaller tunnel running lengthwise of the dam, with vertical shafts giving access to it and to the regulating valves.

The dam is constructed of concrete, of which the aggregate is made up of granite from the hill sides,



The magnificent lake, stretching for many miles, which has been formed by the great dam across the river's course

tween walls at the end of the dam and the rock faces, each of the two byewashes being 400 feet long and 25 feet wide and providing for the passage of 4,000,000 cubic feet of water a minute.

The dam, which is 780 feet long, is curved to a radius of 1200 feet, with the convex side of the curve facing upstream. Springing from the granite rock on either side it is like a great arch laid horizontally. Its width at the top is 18 feet and, spreading downwards, this thickness increases to 168 feet of solid masonry at the base, at the thickest part.

The maximum depth of the impounded water is about 234 feet, to obtain which necessitated the dam's being made 236 feet high (244 feet above the lowest foundation level), the top being 12 feet above highest water level. This provides a storage capacity of 33,380,000,000 cubic feet of water, or about 200,000,000,000 gallons, at a height of 1180 feet above sea level. It is the highest dam in the world, with the exception of two in the United States.

Some idea of the water pressure against it may be gained from the fact that in places, on one foot of its length the pressure amounts to 732 tons acting at a mean height of 76½ feet from the base, the overturning moment amounting to 56,400 foot tons per lineal foot. The weight of the masonry amounts to nearly



nature having favored the enterprise in every possible way, even to the extent of providing practically on the site the bulk of the materials of which the dam is constructed. Even the sand was obtained at a distance of about three miles. Fifty thousand tons of cement were used, and the "plums," as the lumps of stone in concrete are termed, consisted largely of granite pieces weighing 15 tons each.

The preliminary works alone were of no inconsiderable magnitude. A narrow gage railway had first to be constructed from Goondah, a convenient point on the nearest railway, 26 miles from the site. Over this line the necessary machinery and materials had to be transported, including those for providing housing accommodation for some 600 workmen and their wives and families, including a hospital and schools. A cofferdam was then constructed across the gorge above the site of the dam, the normal flow of the river being diverted to either side, to enable work to be commenced upon the foundations. Even these precautions did not prevent great damage to the works occasionally when the river swelled into flood. On one occasion a ten-ton crane, with other cranes and tackle were swept away, portions being carried, it is stated, 50 miles downstream.

The foundation area was first cleared of many thousands of tons of sand, loose stones and boulders, and then a curious effect of scour was discovered. Many large pot-holes several feet deep were found to have been worn in the granite bed of the river, caused by boulders rotated by the swirl and surge of the waters in their headlong course. Here again nature favored the undertaking, for these pot-holes formed valuable keys or dowels to the concrete foundations, assisting to prevent the great structure from sliding under the enormous water pressure at the higher level. The foundations alone occupied about two years to complete.

The erecting plant was driven by electric power. Three overhead cableways were first stretched across the gorge at a minimum height of 320 feet above the river, and spanning 1200 feet between the rocky sides of the ravine. Across these cableways, loads of 15 tons were hauled at a speed of 1200 feet a minute. As the wall was built up, a temporary opening, 28 feet in diameter, was left near the bottom, right through the wall, to allow the river water to pass during the erection of the dam.

When construction reached a height of 110 feet, use was made of the work so far done by utilizing this 110 feet for holding up the river water. Thus 2½ years after work was begun, and about two years before its completion, the dam began its useful service.

Owing to the magnitude of the work it was almost impossible to take photographs which would give an adequate idea of this great undertaking, but our pictures will serve as a bird's eye view of the operations.

A few words may be added as to the nature of the land to be served, for that is, of course, the first con-

sideration of any irrigation scheme. It is stated that the richness of the soil is unsurpassed and that, in addition to its suitability for dairy farming and live stock rearing and fattening, splendid crops of peaches, pears, nectarines, apricots, almonds, melons, grapes, oranges, citrons, vegetables of all kinds, grain, tobacco and several crops a year of lucerne (fodder) are grown.

It is also stated that the New South Wales State Government not only supplies water at the low figure mentioned, but that it affords every possible assistance to settlers in the matter of providing building materials, farm implements and even live stock, on the most favorable terms possible and farms can be acquired at almost nominal rents. These are inducements that may well prove attractive in a district where, so far as can possibly be foreseen, the question of drought will not again arise.

It has been estimated that the outfall below the dam, due to the great head of water above it, is sufficient to

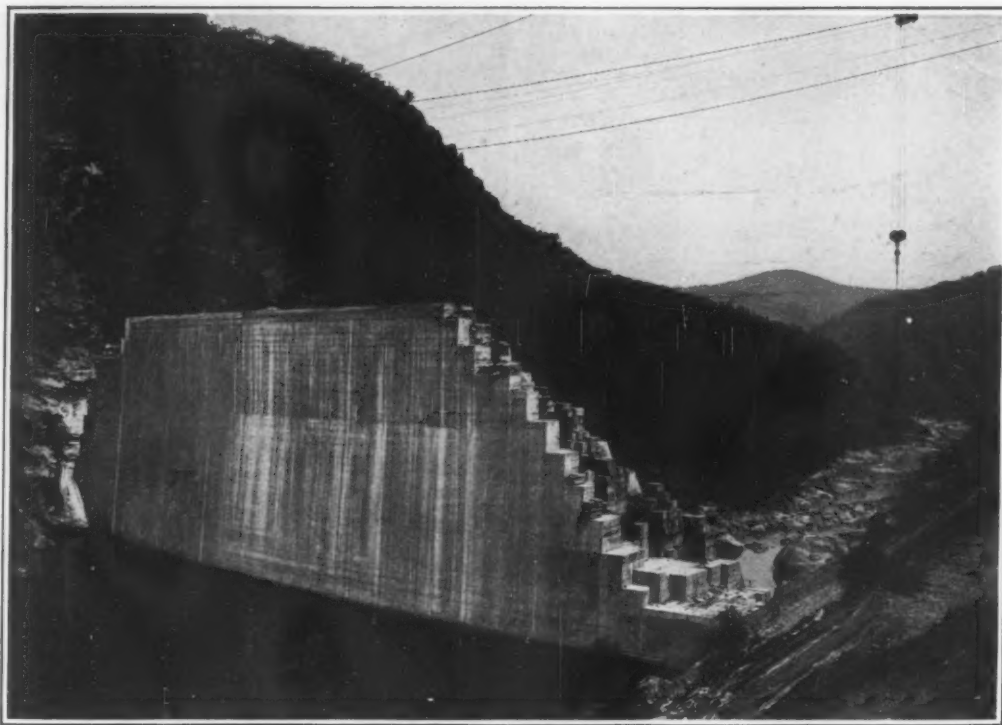
and not solely from the total integrated light emitted. As classed among stars, it is not considered, however, as a regular variable, because the approximate period of 11 years is itself made variable through other minor periods of various lengths.

Though the sun has a dominating action on many terrestrial phenomena, authorities differ as to the exact relation between the pulsations of the two bodies. It is important, therefore, always to keep in mind, so far as possible, the actual state of solar activity at the moment; i. e., whether the sun is in a quiescent state through lack of spots and prominences, or whether it is in a very turbulent condition caused by their abundance.

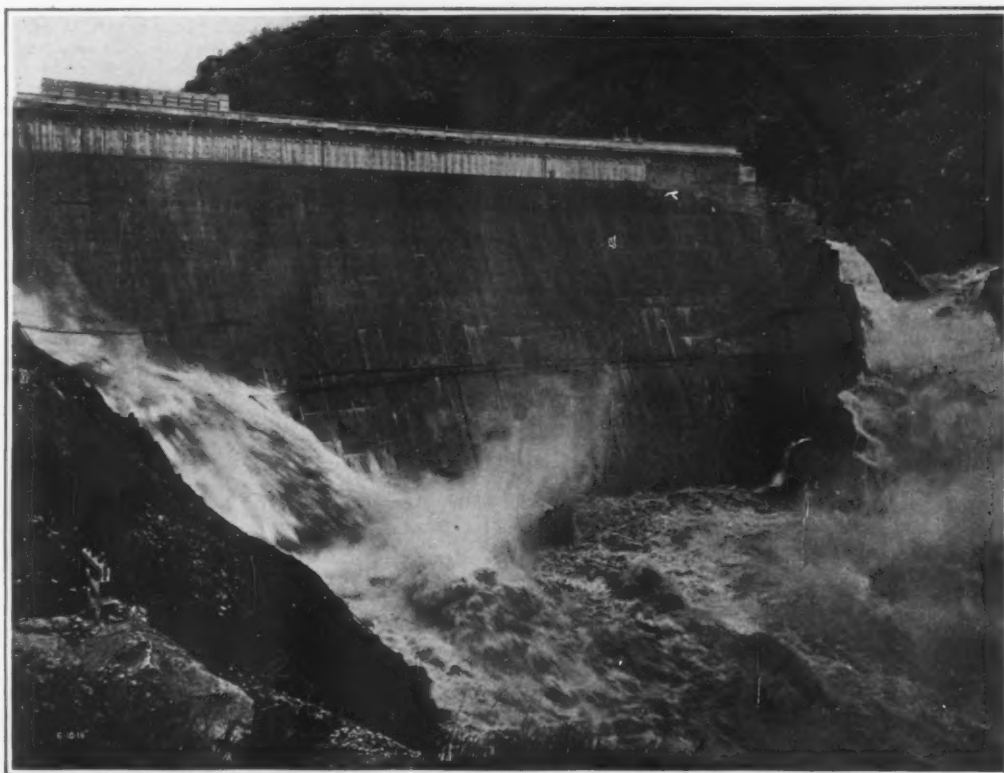
The data for determining the state of the activity of the sun are published separately year by year in various volumes from different sources.

From such sources Dr. Lockyer plots certain curves which show that the maximum spot activity occurred in the years 1893, 1905, and 1917, while the years of minimum were 1901 and 1913.

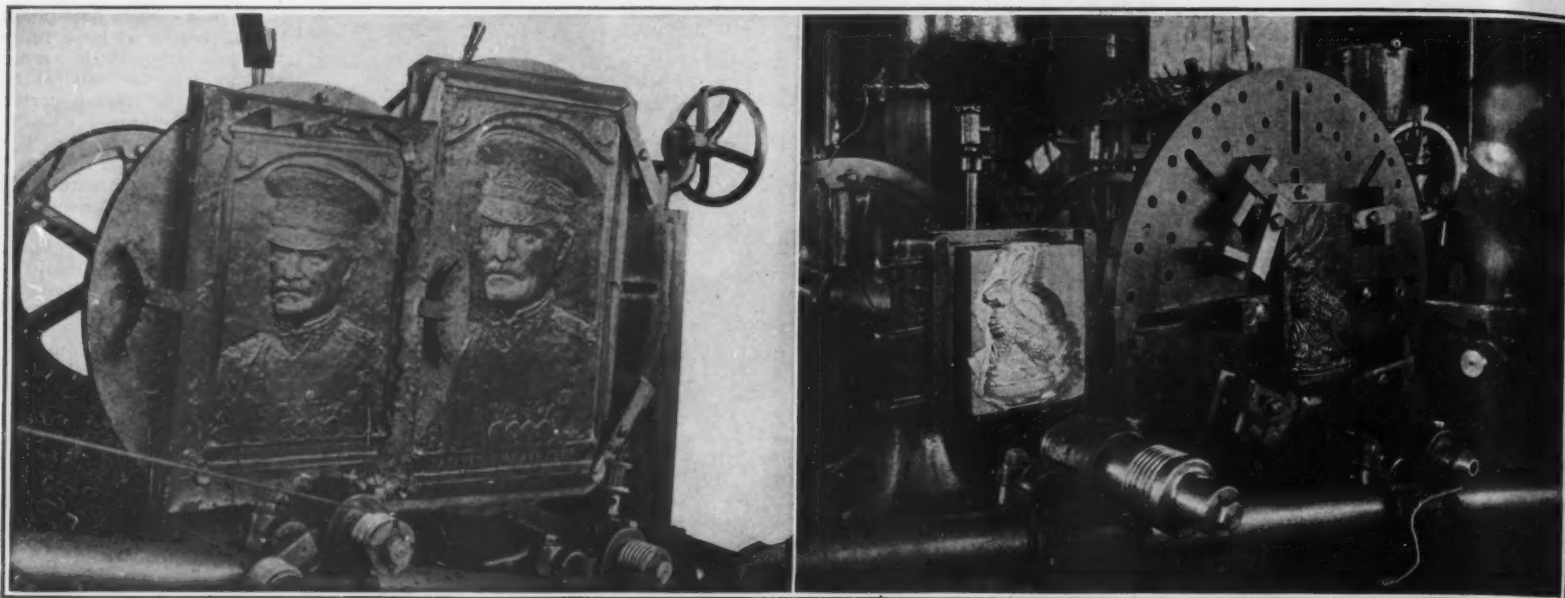
Other curves show that when the corona (polar form) exhibits streamers all around the solar disk; i. e., in all solar latitudes, this indicates a very turbulent state of the solar atmosphere and a time, therefore, of maximum activity. At this time the prominences reach their highest latitudes. When the streamers are confined to the equatorial regions and the poles are quite clear and void of streamers, the corona takes an "equatorial" or wind vane form, and the solar activity is at a minimum. Intermediate stages are indicated by the corona taking an "intermediate" or "square" shape. The various forms of the corona are indicated clearly in the curve by three different symbols. The curve also shows the forms expected in the two approaching eclipses, namely, of this and of the next year. The form for the present year will be of the "intermediate" type, while that for 1923 should be typically "equatorial."



How the great blocks of stone were placed in position by means of an aerial ropeway on which ran a traveling crane



The river not yet wholly chained, boiling down past the edges of the wall



Left: A reducing machine which has been used to prepare the smaller model at the left from the larger one at the right. Right: Close-up of the reducing machine, with the model at the right and the partly finished work at the left, opposite the revolving cutter which appears in the foreground

Two views of the reducing machine for cutting dies, and its work

## A Key to Many Industries

### The New Technique of Die-Cutting, and the Place It Holds in Our Factories

By Robert G. Skerrett

**K**EY INDUSTRIES are those basic activities primarily needful in one direction or another to our diversified manufacturing pursuits. And die cutting and die sinking are very properly classed among these fundamental operations. The terms are familiar ones, yet comparatively few of us know how the work is done or realize how important dies are in turning out widely dissimilar commodities which fit into so many phases of daily life.

To most of us the die is visualized as the exquisite climax of the engraver's art and used mainly in fashioning jewelry, coins, medals, etc. The tendency is to picture the skillful craftsman cutting away patiently and with infinite care upon a piece of soft steel, guiding his tool the while by the aid of a magnifying glass. Time and again we have been told that it may take this artisan days and possibly weeks to model his die and to bring it to that perfection of finish which is characteristic of the best of his handiwork.

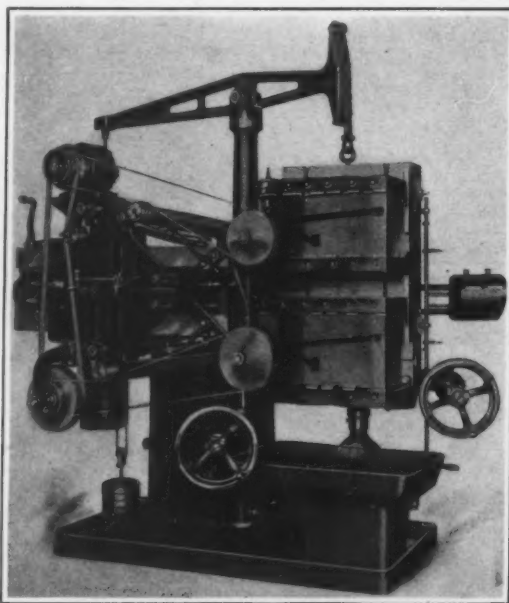
The completion of the die, however, ends only half of the process, for the custom generally is to make one or more "hubs" of steel in which are forcibly impressed intaglios, or the reverse of the die. Fashioning these hubs is, strictly speaking, die sinking, for into their temporarily softer substance is sunk by great pressure the cameo die which has been hardened by tempering. The sinking may require several impressions before the pattern has attained the desired depth and definition; and between each contact with the die the hub may have to be annealed to offset the hardening effect of the pressure and the heat induced.

The foregoing procedure is still practiced to some extent, and a knowledge of the process will aid us to a fuller grasp of what has in latter years been accomplished by the substitution of mechanical mediums of an automatic or a semi-automatic nature which are capable of producing dies as fine as any created by the most facile fingers and the keenest eyes. Not only that, but these newer agencies save time and reduce the number of essential operations, and they render it feasible to manufacture a succession of dies alike in every particular—something humanly impossible when each duplicate die is graven by hand. Further, they obviate the chance of damaging the cameo die.

Die cutting or die engraving machines are the outcome of industrial necessity. So long as there were engravers a-plenty trained in the craft, dies could be made by them fast enough to meet the demands of the users; but the day came not so long ago when our factories speeded up, when standardization was adopted, and quantity production of identical, interchangeable parts, was called for. The die-sinker was suddenly confronted with a problem. Many more people needed his services; and most of them insisted that he

turn out his work not only quickly but that it be of his wonted excellence. These desiderata were antagonistic; a properly finished die takes time and deliberation in its execution.

The solution lay in devising apparatus that could carve metal with the same nicety but far more speedily than was possible with the prevailing hand-guided tool. Success was dependent upon satisfying two prime requirements; an acceptable machine would have to be sensitive to every change of a model's surface and, besides, be of sufficient strength to insure heavy cutting. In other words, the apparatus had to be so designed that it could work directly from the model and thus reproduce every variation of contour upon the prescribed scale. In their earlier forms, these machines were really rather delicate mechanisms, very expensive, and were employed principally in mints or in the establishments of manufacturing jewelers whose activities were big enough to warrant the outlay. Even so, the instruments did not produce a finished die—in a sense they roughed out the design, and a skilled engraver had to give the steel its final touches.



A form of reproducing machine which is capable of cutting at one time a pair of drop-forging dies. The model which guides the cutters is not in view

It is no part of the present article to trace step by step the evolution of the mechanical engraving machine. The goal has been reached, and today there are available, broadly stated, two classes of power-driven die-cutting tools, some of which are well-nigh human in the way they perform their several tasks. Let us take them in the order of their devising, and deal with a typically up-to-date example of the two groups.

The reducing machine, in its present form, will copy exactly a model or pattern which is two, six, eight, or ten times larger than that of the die to be cut from it; and a tool of this sort will, of course, function equally well when the models are in relief or in intaglio. That is to say, by means of this apparatus, hubs or intaglio dies can be cut straightaway, and this obviates the making of a cameo die and the subsequent recourse to the sinking operations previously mentioned. The reducing machine is fundamentally rather simple in its getup, and its outstanding features may be presented without puzzling the average person with an array of engineering particulars.

At the start, imagine two rotating disks or metal face plates set in the same plane and geared so that they will revolve at a similar speed. On one of these disks is secured the model and on the other plate is fixed the metal—commonly soft steel—which is to be cut and fashioned into a die. The two disks are separated a distance which, in relation to a certain point, determines the ratio of the die to that of the model. In other words, the farther the plates are apart the greater the difference in the dimensions of the pattern and the die.

Next, immediately in front of the disks and parallel with them is a strong steel bar which carries both a tracer point and a revolving cutting tool—the first being in contact with the surface of the model and the latter in touch with the die metal. This horizontal bar or arm is supported at one end by a universal joint, and is exquisitely balanced and equipped with anti-friction bearings. A counterweight at the outer or free end of the arm keeps the tracer point continually against the changing face of the model; and, as the tracer travels, its movement is transmitted in kind to the rotary tool which cuts away the contiguous steel agreeably to the predetermined proportion. Once set, a machine of this sort will do its work automatically and accurately, and calls for but a moderate measure of supervision.

Because the designer is permitted to make his model fairly large it is possible for him to develop his details fully and to execute them with much refinement; and the reducing machine will reproduce them exquisitely in miniature owing to the sensitiveness and the positive action of the die cutter. In order to cover the entire surface of both the model and the die-in-the-making,



the tracer as well as the rotary tool move outwardly from a central starting point and follow a spiral course toward the periphery. An ingenious device insures that the rate of progress shall be uniform, like that of the needle upon the record of a talking machine; and by reason of this governor every part of the die is thoroughly dealt with.

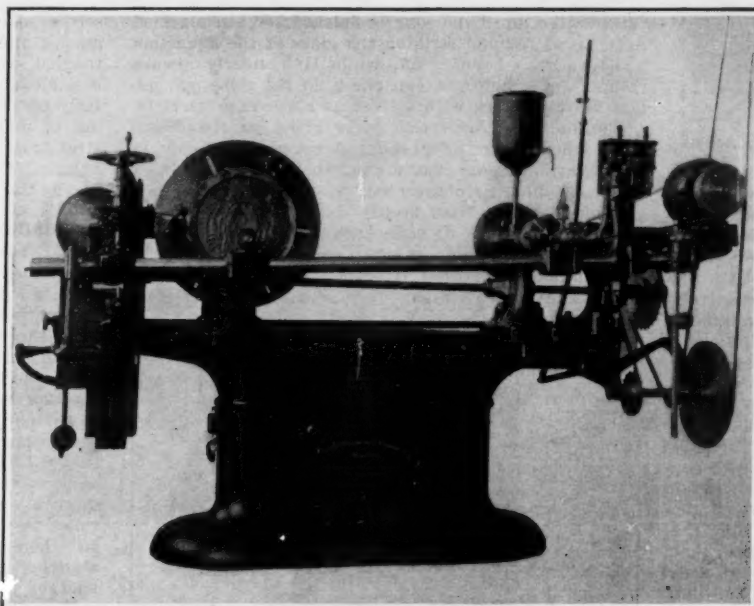
It sometimes happens that the original model is small and quite intricate in design, and yet the die, to be satisfactory, must be a true copy in every respect. Here is where the reducing machine fulfills another purpose; it can be used to make an enlargement in wax of the design, and this can be retouched or so improved as to increase the sharpness of the image, etc. In such a case, the original model is attached to the disk where the die metal is normally secured, and the blank waxen mass is mounted on the plate which is usually reserved for the pattern. It should be plain that the positions of the tracer and the carving tool are correspondingly reversed. When, by this process, a wax enlargement has been obtained, an electrotyping or bronze casting is made from it, and this then becomes the working model for the actual cutting of the die. When such a course is pursued, the resultant die is of a character far beyond the attainment of the skilled engraver. In fact, the machine will do things that defy the cunning of the trained eye and hand of the craftsman. In proof of this, let us cite a single achievement.

When the big British dirigible "R-34" crossed the Atlantic in 1919, she brought to this country a shipment of platinum, and it was decided that some of this precious metal should be used for a number of miniature medals commemorative of that remarkable aerial journey. The inscription chosen was rather lengthy, and it was necessary that each letter should be perfectly formed so that the text could be read by strong eyes or by aid of a magnifying glass of low power. It was equally desirable that the details of the decorative features should be reproduced without blurring. The artist's task was a fairly simple one, for he was at liberty to make his model upon an ample scale; the real difficulty arose when a search was made for an engraver with sharp enough vision and a sureness of touch capable of cutting the dies required for striking off the decidedly small medals. As a matter of fact none could be found. The medals would probably still be unmade but for the reducing machine.

A New York manufacturer of apparatus of this description, who is likewise engaged in the production of dies and metal molds, came to the rescue; and by utilizing the facilities at his command succeeded in cutting two little dies, one for the obverse and one for the reverse of the "R-34" medals. Every feature of the original models was accurately copied, and the tiny letters of the legend stood out clear and clean cut when examined under a reading glass. This performance was evidence of the extent to which instrumentalities of this kind have advanced since they reached a practical stage a comparatively few years ago. In their earlier forms, mechanical die cutters did only part of the work, and the engraver did the finishing; today thoroughly rugged machines are able to carry to completion tasks that defy even the most expert of artisans.

And now we come to another aspect of the art, a later development, the duplicating machine. This type of die-cutting apparatus operates somewhat differently from the reducing machine and yet embodies a number of the principles which are typical of the older equipment. In the duplicating machine, the movements of both the cutter and the tracer are not only alike but

are of the same amplitude; and the model and the die travel up and down instead of revolving. As in the reducing machine, motion is here possible in three directions. Either apparatus can function continuously for 24 hours a day—something quite beyond the powers of endurance of the most vigorous of engravers; and the character of the output never varies. Besides, the mechanical product can be turned out at a much higher rate of speed than is feasible by hand.



A comprehensive view of an up-to-date reducing machine. The tracer point is in contact with the model mounted on the large disk at the left, while the cutter, farther to the right on the same supporting arm, is machining the steel block carried on the much smaller disk.

It will be readily understood that the tracer goes successively over every part of the model and, in doing so, guides the motion of the cutter which removes the steel in contact with it in exact ratio—in brief, creates a duplicate. As often as otherwise, the model is not a pattern in the usual acceptance of the term but is a finished article—half of a mold, for example. Thus, when one member has been damaged or broken, the duplicating machine makes it a comparatively easy

that of hardening in the case of steel is necessary.

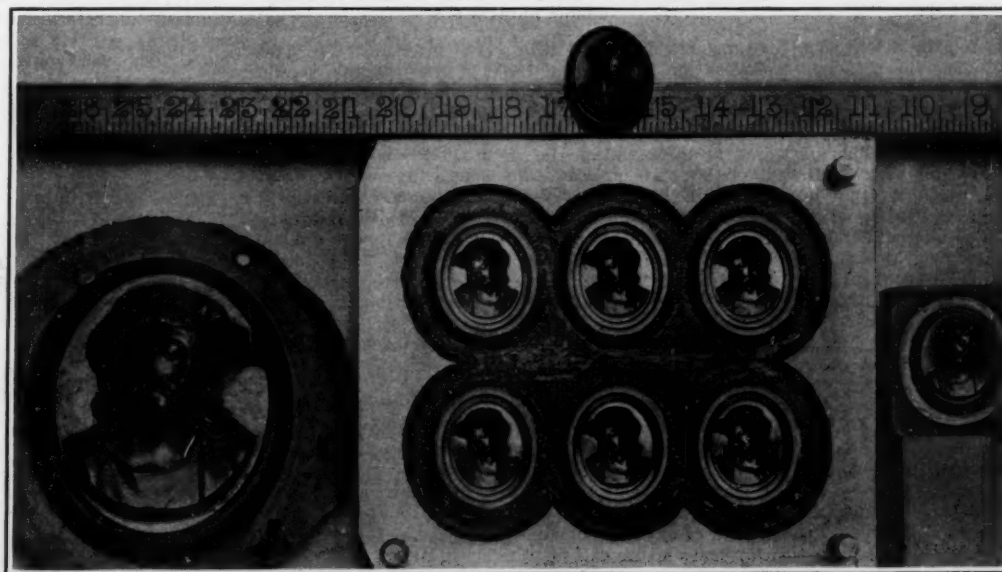
Reducing and duplicating machines of various sorts are built to make dies and molds for scores of purposes, that is to say, they aid in the manufacture of arms, ammunition, automobile parts, aluminum and brass ware, electrical appliances, cutlery, rubber articles, hardware, horseshoes, harvesting machinery, surgical instruments, paper goods, valves and fittings, leather, glass, toys, etc., not to mention silverware,

jewelry, and kindred adornments. In all of these services, we see the reflex of the modern effort to employ mechanical agencies wherever practicable so as to obtain results of a uniform excellence which could not be had if dependence were placed alone upon manual cunning. Similarly, the aim is to save time and money.

Die cutting has today a new significance; and this can be gathered from the foregoing recital of the ways in which the products of die and mold-making machines fit into our industrial life. This list of uses is, however, an incomplete one, and year by year grows longer. The reason for this is that the machines are gradually being adapted to handle larger and larger masses or blocks of metal which, when carved into their ultimate shapes, are able to give other materials commercial forms essential to the comfort, the convenience, and the daily pursuits of the general public. It is a far cry from jewelry to tractors, and yet the die-cutting machine now figures in the repetitive production of both. The graving tool of the expert has been outdone, surpassed, by power-driven apparatus capable of meeting greatly differing demands with astonishing precision and speed. One might expect these instrumentalities to be complex, but they are not; they are striking examples of simple mechanical principles brought into harmonious cooperation by engineering cunning of a high order. Then, too, these machines are but another proof that ingenuity can devise machinery to do anything but think for itself.

#### Bacteriology of Canned Meat and Fish

A RECENT report of the Food Investigation Board (British) on the bacteriology of canned meat and fish is of interest. The report is based on the examination of 344 samples, the object being to ascertain the character of bacteria concerned in the spoilage of these canned goods. According to the report molds and yeasts are of rare occurrence and probably of little importance. Obligate anaerobic bacilli are rarely present in sound tins, but are nearly always associated with obtrusively decomposed conditions in the tin. Sporulating aerobic bacilli are frequent in sound samples, and many of them must be regarded as potential causes of decomposition; they are unable to develop in sound tins from which air is excluded and persist as harmless spores. Non-sporulating bacilli were found in many samples, their importance depending upon their biological characters. Thus, strains of *B. proteus* are important causes of decomposition. Thermophilic bacteria (i. e., bacteria growing best at 55 deg. Centigrade) were searched for and found to be widely prevalent but, being non-proteolytic, are unlikely to cause spoilage. Micrococci are infrequent and as a group cannot be regarded as a cause of spoilage, though they may assist more proteolytic types of organisms. Nearly 62 per cent of sound tins are not sterile, the worst offenders being crab and lobster. Sterility itself is therefore not a criterion of soundness, and these surviving bacteria do not in any way injure the foods in which they are present owing to their inability to multiply and produce decomposition under the conditions existing.



At the left the artist's model, at the right a mechanically reduced replica in steel, and in the center a multiple die of the same subject, intended for striking off simultaneously a number of these plaques, and hence reversed. At the top, a piece of jewelry made in this fashion.

#### Some details of the die-cutter's accomplishments

matter to provide a replacement, the surviving unit serving as a pattern. The same practice can be followed in cutting the twin parts for dies used in the manufacture of many drop forgings. In fact, apparatus of this nature are pretty generally relied upon today to fabricate what are known as "matched" or "locked" dies, which have many fields of usefulness. By these agencies blocks of steel or cast iron can be machined rapidly into the desired form—a simpler proceeding than casting, and frequently no treatment other than

unlikely to cause spoilage. Micrococci are infrequent and as a group cannot be regarded as a cause of spoilage, though they may assist more proteolytic types of organisms. Nearly 62 per cent of sound tins are not sterile, the worst offenders being crab and lobster. Sterility itself is therefore not a criterion of soundness, and these surviving bacteria do not in any way injure the foods in which they are present owing to their inability to multiply and produce decomposition under the conditions existing.



Spring peeper (*Hyla pickeringi*) caught in the act of singing; a little more than life size

**M**ORE general information is desired about those creatures of the swamps and water-courses, known to naturalists as *Hyla* and *Acris*, or in more common if less specific parlance, as the spring peepers and the cricket frogs. We know comparatively little as yet of their general habits, and anything thereon must be considered as merely a contribution.

One finds that the authorities are sometimes a little short on the facts regarding these largely nocturnal and elusive animals, which is really not surprising. Gibson in "Sharp Eyes" evidently got most of his information second hand, which was generally not his way. He pictures the cricket frog incorrectly; no one could recognize the species by his figure. In Dickerson's "Frog Book" we are told that the call of the cricket frog has not great carrying power; that the creature is diurnal; that its song is like a cricket; that its yellow throat is inflated enormously; that it does not hide under moss and grass while singing, like Pickering's frog; that it cannot climb and that its chorus is loudest in late April and early May, most of which is altogether incorrect.

The cricket frog is an interesting study; no batrachian could be more so. It is diurnal, also nocturnal; awake at one time as well as at another and when it sleeps I know not. The nearest resemblance to its song is the striking and scraping of two quartz pebbles, or pieces of ringing glass. The bottoms of thin tumblers brought into contact first by a sharp tapping and then by hard friction serve pretty closely to imitate the sound. That the soft, membranous, inflated throat of such a tiny creature can produce such a metallic sound, loud enough to be heard for many hundred yards, is one of nature's veritable wonders. When the sound is traced to the author the beholder is dumbfounded at the size of the animal which may be perched upon a floating leaf or twig, upon a reed stem or down deep in the grass by the water's edge. The insect music which most nearly resembles that of the cricket frog is the chip, chip, chip, like softly striking pebbles, of the false katydid, *Microcentrum retinervis*, which is made by rubbing the wings. The shrill fiddlings of crickets do not even slightly resemble the frog's call. The common name is, therefore, a misnomer; that of castanets frog would more correctly suggest the notes.

Beginning slowly, increasing in speed and power until the metallic clickings run together like a scraping sound, a single *Acris* makes noise enough for several, and when there is a chorus of them among the flags by pond or river brim the racket is almost deafening. When fishing or river exploring and collecting I have frequently run the nose of my boat among the water grass to spy on the creatures, but not successfully. The call of the castanets frog is loudest during hot weather and at that time there is most apt to be heard the day and night chorus of perhaps a half dozen or more individuals, the sound carrying often for half a mile or more.

Recently with lantern and butterfly net I captured several of these castanet players, after a most exciting hunt, and in a roomy aquarium, furnished like a bit of marsh, the tiny animals have favored us with many performances. They are wild and not so easily observed as the spring peepers, *Hyla pickeringi*, nor do they sing as often; nor as readily respond to imitation. Both species begin their piping, or rattling, whenever there is a distant, air-disturbing, continued sound, as music in another part of the house, the open exhaust of an automobile a hundred yards away, and invariably after or during thunder, so that when a storm is in progress the little fellows make quite a racket. Evidently they regard old Jupiter Pluvius as one of their number, or possibly as worthy of competition.

The throat of the cricket frog does not swell as enormously as that of *Hyla*, nor does it assume the very spherical, bubble-like form and color, but it equals in size about one-fifth of the frog's body and retains its

full inflation until the song is finished. When alarmed *Acris* leaps far and striking the glass of the aquarium nearly always bounces off, while *Hyla* nearly always clings. *Acris*, however, can climb up the glass and adhere to its surface with almost as much ease as *Hyla*.

Specimens of *Acris* that were green on the dorsal band when taken have changed color remarkably in the aquarium; some after a week show the band a brick red, some have it obliterated, while the general body tint of all varies from bronzy-black in new specimens to pale olive green or sage green.

Of the interesting spring peepers much has been written, but it is largely repetition. A search for them during May reveals many upon brambles, young trees and bushes as far as fifty feet from the water and from an inch to five feet above the ground. Others



Spring peeper on the side of an aquarium; about double natural size

remain on flags and tall water grass by the pond borders and among the tangled grass of the marsh. In the aquarium they become tame, piping frequently and in chorus. With each shrill pipe in which the average singer reaches the highest key on the piano and the highest G on the violin the air is forced from the inflated abdomen into the spherically swelled throat which, though already very large, increases greatly at each utterance and decreases at the end of it. But the frog will sit for a long time with its throat swelled out, though making no noise; then it will suddenly begin piping again. *Acris* does much the same, but less violently, the inflation being maintained about the same size throughout the performance.

Dissection shows the abdominal muscles of *Hyla* wonderfully developed. When climbing *Hyla* uses the flat, reticulated surface of its abdomen, as well as its disc-like toes, to aid it in adhering to a smooth surface. This is noticeable on vertical glass. *Acris* does the same, but adheres only by an apparent effort.

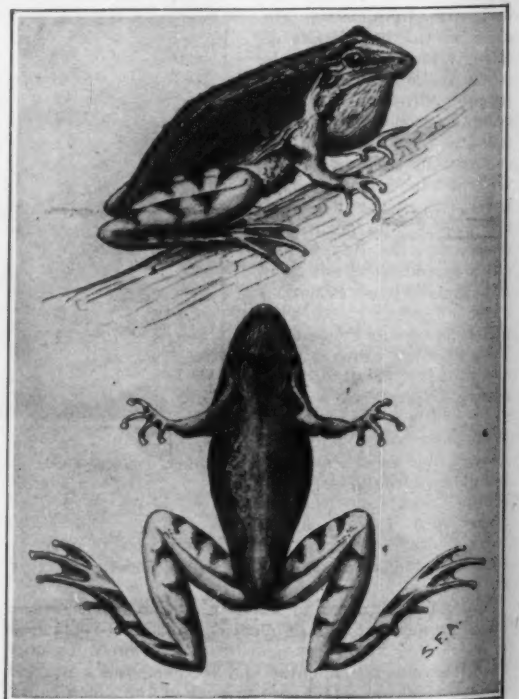
As is well known, the common tree frog, *Hyla versicolor*, after laying its eggs and going through its larval transformations in the manner of all amphibia in the water, often wanders far over dry places in its search for food and its call may be heard at any time during the summer, especially preceding rain, or when the weather is humid and the sky clouded. The spring peepers have similar habits, with the exception of continuing to use their voices; they become silent after the vernal chorus has served its purpose of bringing the sexes together, which is commonly the cause of the singing by the males of all frogs and toads. Though less observed largely because of its silence, Pickering's *Hyla* has been found in midsummer fully a half mile from water and in the top of high trees.

*Acris* sticks to the water, probably never wandering a yard away from its native pools; its frequently sounded castanets enable the observer to keep an ear, if not an eye on its whereabouts. In this matter of observation the minstrel frogs are so small they so closely resemble their surroundings and they hide them-

selves so completely from a host of hungry enemies among the dense foliage of thickets or masses of tangled water grasses that it is only by simulated aquarium methods that their life histories may be fully understood. Then, too, the aquarium methods permit of making photographs and drawings of the minstrel frogs, which would be impossible in their native haunts. The accompanying drawings were made from life by the author.

### Fundamental Electrical Units and Standards

**T**HE electrical units which are in use in the measurement of power and in various scientific and technical investigations are what are known as the international electrical units. These units were intended to be the same as the corresponding units based on the centimeter, gram, second system of units. However, the fundamental measurements on which the specifications for these units are based were made more than 30 years ago. In the meantime there has been a marked improvement in electrical measurements generally, and a few fundamental measurements made more recently show that the magnitudes of some of the international electrical units differ from the magnitudes they were intended to have by fully one part in two thousand. Consequently, if we are to have and use electrical units which are to be considered definitely a part of the general system of units so that, for example, a watt measured electrically and a watt measured mechanically shall be the same, we must make suitable measurements in such a way as to determine the magnitudes of electrical quantities in terms of the units of the fundamental magnitudes, namely, length, mass and time. The Bureau of Standards is, therefore, taking up again work on fundamental electrical units which was begun soon after the bureau was established, but which had to be discontinued some years ago. The work now in progress is on the measurement of inductance and resistance. Presumably work on the measurement of current will be taken up after work on these two has reached a satisfactory stage. To make the results of this investigation more reliable and to reach a fair estimate as to their reliability, it is planned to carry out the measurements in different laboratories using independent observers and as far as possible independent methods of measurement. The work now in progress on inductance and resistance will require several years for its completion, and very probably the work on the measurement of current will require an equal time.



Two views of the cricket frog; the upper one singing (*Acris gryllus*)



## Powerful Wrecking Derrick for the Virginian Railway

THE United States Railway System is favored by the fact that its "loading gauge," that is to say the clear width and height of its tunnels and through bridges, is greater than that of the British and Continental Systems. The advantage of this is shown in the greater size both of the locomotives and of the cars on our railroads, the weight of the former reaching several hundred tons and the freight cars having a size which, in the largest, reaches a carrying capacity of 120 tons. These great dimensions make it possible to haul trains of a length and weight which are not approached on any other railroad system; and the economy with which freight can be hauled in this country is due very largely to the great size of individual locomotive and train units.

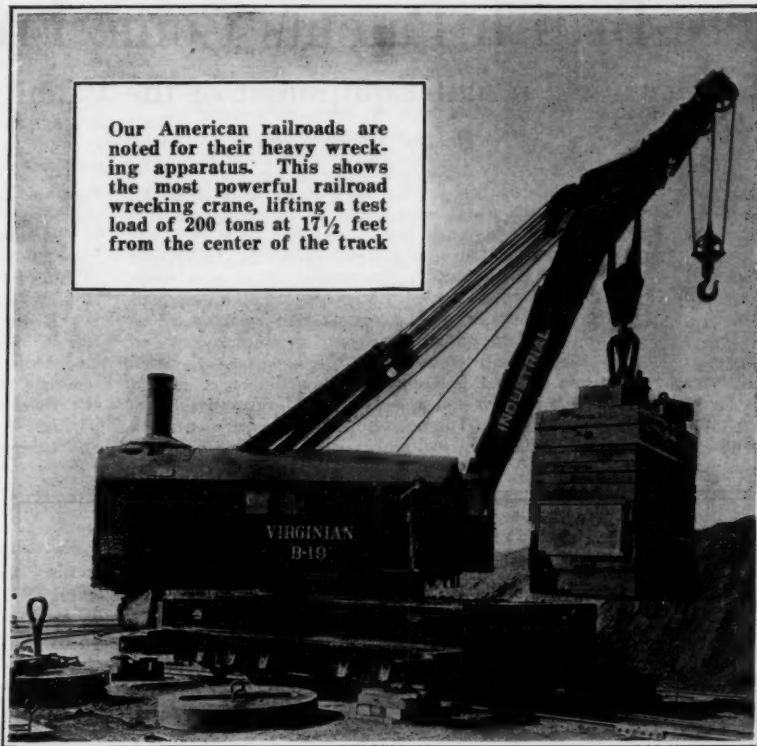
It is this heavy weight of locomotives and cars which has led to the construction for American railroads of extremely powerful wrecking apparatus; and the largest wrecking cranes in the world have been built in the United States. Until recently the largest equipment of this character was a 160-ton unit which had a lifting capacity of 160 tons when all the outriggers for stabilizing the crane were in use.

By courtesy of Mr. H. Fernstrom, Chief Engineer of the Virginian Railway Company, we are enabled to present an illustration of a remarkable derrick, built by the Industrial Works, Bay City, Michigan, for the Virginian Railroad, which is the largest wrecking crane ever constructed. This machine has a capacity, on the main hoist, of 200 tons at a radius of 17½ feet from the center of the track, when all the steadying outriggers used to prevent the capsizing of the crane are in place. With only the end outriggers in use, the crane can lift 100 tons at the same radius, and 42½ tons can be lifted at 17½ feet radius without the use of any outriggers. Our illustration shows the new crane making a lift of 200 tons at 17½ feet radius with all the outriggers in place. The outriggers, it should be explained, are heavy steel I-beams which can be extended from the platform of the car to rest upon blocking built up from the ground, as shown in the illustration.

The auxiliary hoist at the outer end of the crane has a capacity of 45 tons at 24 to 30 feet radius, with end outriggers only; and a capacity of 30 tons at 24 feet without any outriggers.

The crane is mounted on special 6-wheel trucks which were designed for a maximum allowed load, in running order, of 64,000 pounds. The car is 34 feet long, and it has a total wheel-base of 26 feet 2 inches. The crane is 15 feet 9 inches high at its highest point, and its extreme width is 10 feet 6 inches. The hoisting engines are 12 inches in diameter by 12 inches stroke, and steam is supplied by a 65-inch A. S. M. E. boiler. Clasp brakes are provided on each of the 12 wheels, the brakes being operated either by the engineer on the crane, or by the engineer of the locomotive which may be hauling the crane as part of a train. The clutches are air operated. The total weight of the crane in running order is 178½ tons.

Our American railroads are noted for their heavy wrecking apparatus. This shows the most powerful railroad wrecking crane, lifting a test load of 200 tons at 17½ feet from the center of the track



In building this powerful machine the main problem of design was to keep within the railroad clearances and not to exceed the maximum allowable axle load, as determined by the bridge engineers, of 65,000 pounds; and within these restrictions to obtain the 200-ton lifting capacity, called for by the unusually heavy rolling stock and motive power which characterizes the Virginian Railroad.

## The Sources and Characteristics of the Bacteria in Decomposing Salmon

IN studying the distribution of the bacteria concerned in the decomposition of salmon, 316 cultures were collected from sea-water, from decomposing salmon and from salmon canneries throughout southeastern Alaska. After discarding those cultures which were soon recognized as duplicate, 85 cultures were kept for further study. One of these cultures was *Actinomyces*, one was a pink yeast, and four were white yeasts. Of the remaining 79 cultures 72 were rod-shaped organisms without spores, 3 were spore-forming rods, and 4 were streptococci.

While no attempt was made to identify specifically many of the cultures, six were identified as *Bact. cloacae*, three as *Bact. aerogenes*, two as *Bact. coli*, one as *Bact. communior*, and four as *Ps. fluorescens*. The majority of the bacteria collected apparently belong to a large group of non-fermenting soil and water bacteria.

Of the original 316 cultures 71 were *Ps. fluorescens*, 27 were *Bact. cloacae*, and 12 were cultures of an unidentified flesh-colored organism represented as Culture 360. The predominance of these three organisms,

when considered in connection with their decomposing action on salmon, indicates that they play an important part in the decomposition of the salmon, and that they might therefore be profitably made the subject of further study.

Eighty per cent of the bacteria collected from sea-water were also found in decomposing salmon, in the canneries, or in both. Approximately 52 per cent of the salmon cultures were also found in sea-water or in the canneries, and about 34 per cent of the cultures from the Alaskan canneries were also obtained from other sources.

The results of this investigation confirm the statement previously made that the bacteria concerned in the decomposition of salmon are those forms which are regularly found in the sea-water from which the salmon are taken and that the decomposition of salmon is not due to bacteria which contaminate the salmon within the cannery.—*Journal of Bacteriology*, 7 (1922): 85.

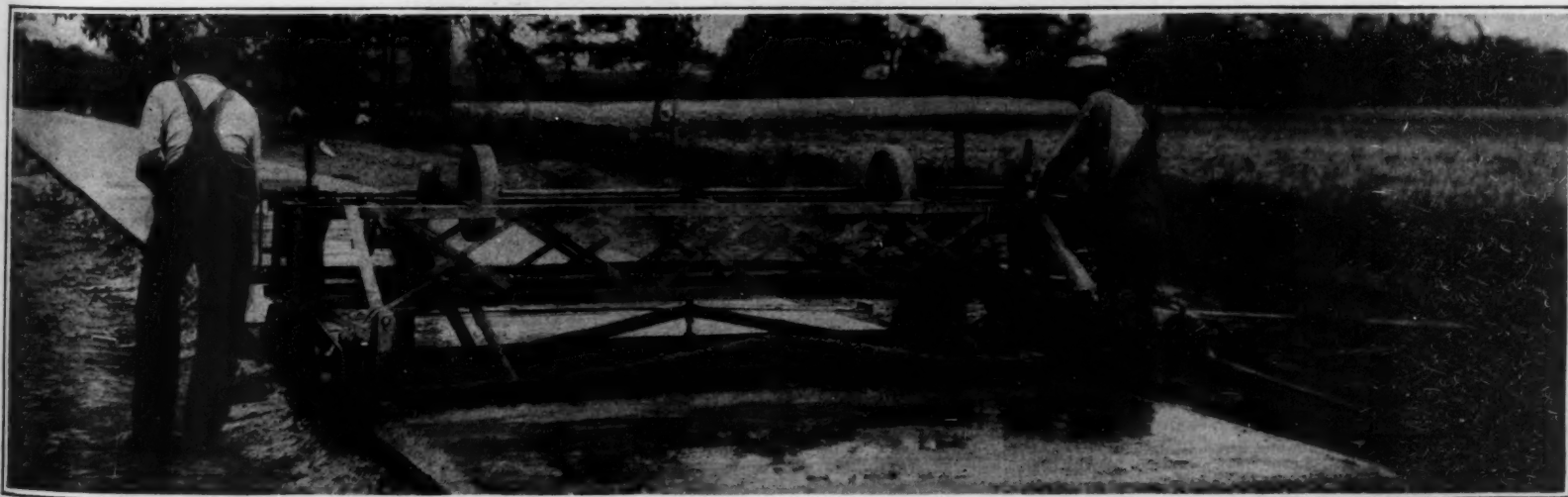
## Hand-Operated Highway Tamping and Finishing Machine

IN past years, and until a comparatively recent date, in building new roads it was customary to give the surface its final tamping and finishing by means of hand-operated machines. These were followed by the development of machines for finishing concrete roads and for tamping the base for brick roads, in which power was supplied by means of a gasoline motor.

Recently the Heltzel concern of Warren, Ohio, has developed the hand-operated finishing machine, which forms the subject of our illustration. They have built this device under the conviction that there was a call for a hand-operated finishing machine which would fill the gap between direct hand-finishing and motor-finishing, and they tell us that the approval of the road contractors, and of the State highway engineers of a dozen of our leading cities, indicates that they are working in the right direction.

The machine is made entirely of steel, and the framework, being rigidly reinforced, gives a satisfactory support to the drive shafting. Cams are fastened upon the latter which serve to lift a roller that is attached to the strike-off. The action is such as to give a vertical as well as a lateral motion, thereby ensuring a correct crown to the road.

Directly in front of the machine is a steel strike-off; back of this is the tamper proper; and the member back of the tamper proper is another strike-off, which serves to catch any unevenness that might be missed by the preceding members. The final member is the wood finishing belt. All four members function as the two operators turn the crank handles. Power is transmitted from the crankshaft to a pair of wheels on each end of the machine, which run upon tracks that limit and confine the concrete roadbed. The machine can be operated forward or backward as may be required, and adjustments are allowed should the various members lose the crown given them. The machine here shown is being used on forms having the pedestal method of support, the form proper being made of three-sixteenths-inch steel.



A successful, hand-operated road tamping and finishing machine in operation. By turning the two end cranks the workmen do the tamping and finishing

# Where British Patents Come From

## Something of the History and Present Equipment of the Patent Office in London

By Hector C. Bywater

**R**EADERS of "Little Dorrit" will recall how Charles Dickens made this story the vehicle of his trenchant attack on the bureaucratic methods prevailing in those days. In his inimitable style he narrates the misadventures of one Daniel Doyce, an inventor, and his friend Arthur Clennam, in their efforts to secure official recognition for Doyce's epoch-making device. The "Circumlocution Office," we are told, regarded the inventor as the enemy of his race, and treated him accordingly. "The moment he addresses himself to the government he becomes a public offender. He ceases to be an innocent citizen and becomes a culprit."

Though Dickens, no doubt, overdid the picture, it is true enough that down to the second half of the nineteenth century the path of the British inventor was beset with thorns. A patent application had to go through seven different government offices before it was finally approved and the cost of a patent covering England alone was about £100. If patent rights were desired for Scotland and Ireland as well, a further £200 had to be paid. This was, of course, a prohibitive charge when, as so often happened, a needy student or mechanic hit upon a new device for improving some branch of the arts and manufactures. Unless he could enlist the interest of a wealthy patron he had no chance either of marketing his invention or protecting his rights therein, and even if he did secure such aid his share of the profits was usually small.

In the old days the term "patent" had a much wider significance than it has since come to bear. "Patents of Monopoly" were granted by the Crown for a variety of purposes, and not infrequently led to grave trouble between the monarch and his subjects. Queen Elizabeth once raised a storm by permitting certain favored subjects to "corner" salt and other necessities of life, with the result that prices soared high and there was an outburst of popular wrath that threatened to shake the throne. It was then that the shrewd and tactful Queen revoked the obnoxious privileges and pledged herself never again to grant monopolies to the detriment of her faithful subjects. This pledge she loyally observed. The practice, however, was revived by her successor, James I. In the files of the Patent Office you may see the text of a certain Patent of Monopoly dated 1620 which possesses great historical interest, for this particular grant led to the Statute of Monopolies of 1624, which virtually put an end to the whole unsavory business, and incidentally brought about the disgrace of Francis Bacon, then Lord Chancellor. Drawn up in favor of a group headed by Sir William St. John, Sir Giles Mompesson and Sir George Ayloffe, it granted "unto them, their executors, administrators, deputies, servants and assigns onely, and none other, the full, sole, absolute and free libertie, power and authoritie, for and duringe the terme of one and twentie yeares from henceforth next ensuinge, to charke or otherwise to convert into charkcole, any and all manner of seacole, stonecole, pitcole, eartheole, moorecole, turfe, peate, brush, flagg, and cannell, and all other fewell or combustible matter of what nature or qualitie soever that same may be (woode onlie excepted)." . . . This truly comprehensive "patent" was, of course, a monumental piece of "graft," the sequel to which came a year later when Sir Giles Mompesson was convicted of fraud, sentenced to be degraded from the order of knighthood, imprisoned for life, and, lastly, "that he be ever held an infamous person." Among the personages implicated in this scandal was, as has been mentioned, Francis Lord Bacon, who forfeited his high office and was mulcted in a heavy fine.

In the early part of the eighteenth century it was enacted that persons claiming proprietary rights in any new invention should be compelled to submit a

specification of the same. Several more or less important modifications were made in the procedure during the next 150 years, but it was not until the year 1851, when the tide of industrial enterprise in Britain was at the flood, that a determined effort was made to simplify and facilitate the process of obtaining patent rights. In that year a commission was formed to examine into the patent laws, and its main recommendations were duly embodied in the Act of 1852, which abolished the old and cumbrous machinery of patent legislation and vested the power of granting patents in a single office. The next important amendment took place in 1883, when examiners were appointed to deal

possible, and he can always count upon expert advice courteously given. In the granting of patents there is no longer any delay beyond what is absolutely necessary in order to establish the propriety and validity of the claim. Disputes between rival inventors which, if allowed to develop, might lead to costly and futile law suits, are often settled through the arbitration of the Comptroller of Patents or his deputy, whose wide knowledge and experience enable them to determine whether a claim is well-founded or not. In a word, the British Patent Office now ranks as a highly important factor in the development of human ingenuity and enterprise, and were Dickens still with us he would doubtless be the first to admit as much.

The Patent Office Library contains what is believed to be the finest collection of technical literature in existence. Including the patent specifications, which go back as far as the early seventeenth century, there are more than 200,000 bound works, embracing nearly every language. The library is also in receipt of some 3000 technical periodicals from all parts of the world. Admission is free, and the visitor is allowed to roam at will through the spacious apartment, taking down from the shelves such works as he needs, and finding every convenience at hand for quiet study or copying. The library owes its inception to the late Mr. Bennet Wood-

croft, himself a successful inventor, who in 1864 was appointed Clerk of the Commissioners, a post that placed him in sole control of the then Patent Department. His own collection of objects and manuscripts dealing with early inventions formed the nucleus of the present magnificent library. He it was, too, who contrived to have all patent specifications from 1617 to the date of his appointment, about 15,000 in number, printed and published, thus making them easily accessible. Thanks largely to his influence, the Patent Office Library was opened to the public in March, 1855. At that time little better than a cellar, cramped, badly lighted, and ill-ventilated, it was familiarly referred to by its habitués as the "drain pipe."

As time went on many more volumes were added, and this, together with the growing number of readers who frequented the room, made it essential to transfer the collection to more commodious premises. The new library was built in 1898. The public room is 140 feet long and the height 50 feet. On each side there are two galleries, the books and specifications reposing in shelves along the bays which open out from the ground floor and the galleries. The arrangement is such as to make the finding of any volume or patent specification the work of only a few minutes, and in case of difficulty advice is promptly given by the Librarians, whose unfailing courtesy is proverbial among the readers. The rarer and more valuable books, manuscripts and prints are not kept in the public room, but access to them is readily granted to any responsible person. A bare catalog of the many treasures contained in the library would occupy much space. Here may be found learned treatises on science and mechanics that were printed more than 400 years ago, and when turning the leaves of these ancient volumes it is

no uncommon experience to light upon a primitive drawing or quaintly-phrased description of some mechanical device which we are accustomed to regard as of quite modern date. A case in point is that of the roll-top desk, a description of which, differing in no essential from the modern article, was given by M. Roubo in "Description des Arts et Métiers," printed at Paris in 1772. In a book by William Bourne, on "Inventions or Devices Very Necessary for All Generall and Captains, or Leaders of Men, as Well by Sea as by Land," published in London in 1578, we came across a primitive type of submarine, and drawings of an early terrestrial telescope.

(Continued on page 287)

**W**HAT would be the feelings of the inventor of today, if he discovered that in order to obtain protection for his invention, his application had to go through seven different government offices before it was finally approved, and that the cost of his patent would be \$1500? Yet these very conditions obtained in Great Britain even as late as the second half of the Nineteenth Century. We commend for careful reading Mr. Bywater's condensed story of the evolution of the patent laws of Britain from the Middle Ages down to the present era.—THE EDITOR.

with all patent applications, and other reforms were introduced. The rules as then revised still govern the functions of the Patent Office, subsequent acts passed in 1905 and 1919 having made only slight changes in the procedure. At the present time the staff of examiners and assistant examiners numbers between 200 and 300. This concentration of expert knowledge, covering as it does every branch of science and industry, not only ensures to the inventor an authoritative judgment on his claims, but acts as a safeguard against the infringement or duplication of existing patents; saves the time that would otherwise be wasted in the impossible task of giving effect to chimerical schemes;



British Patent Office Library, said to contain the finest collection of technical literature in existence, including 200,000 bound volumes and 3000 periodicals from all parts of the world

and protects the public from frivolous, pernicious and undesirable inventions.

Officials of the Patent Office inform me that the war seems to have had a stimulating effect on the inventive faculties of the community. The volume of patent applications has never been so great as it is today. Upwards of 30,000 had been filed during the period from January 1 to November 11, 1922, and the total for the year was expected to reach nearly 34,000. If the British inventor's lot was a hard one when Dickens wrote so scathingly of the "Circumlocution Office," his modern successor certainly has no reason to complain of the treatment he receives from the patent authorities. They are there not to impede, but to help him in every way



### Car and Locomotive in One

A REMARKABLE type of railroad vehicle recently designed in Winterthur, Switzerland, may be described as a combination of locomotive and passenger car. The locomotive section comprises a 250-horsepower internal-combustion engine, which is able to impart to the vehicle a speed of up to 44 miles per hour. The passenger compartment has seating accommodation for 70 third-class passengers. One or two ordinary passenger cars (according to gradients) may be coupled to the combined vehicle, thus forming short trains.

Extremely low fuel expenses are the main advantage of the new system over a steam engine service. The vehicle, which has the considerable weight of 65 tons, is said to consume only four gallons of fuel on the 20-mile line from Winterthur to Frauenfeld, the cost of which is about equivalent to the price of one third-class ticket for the same distance. The new system, however, can be readily adapted as well for locomotives and is expected to produce something like a revolution in locomotive construction. The total running expenses are considerably lower than in the case of either steam or electric operation, being only about one-half as much. While the main problem so far to be solved in railroad operation was relative to the ultimate supremacy of either steam or electricity, a third competitor will in future have to be taken into account.

Trial runs with this vehicle are being made in the presence of Federal railroad officials on the Zurich-Romanshorn line of the Swiss Federal railroads, no hitch having so far occurred.

### Another Walking Tractor

AFTER having exhibited at the Prague Motor Show last year a small model of a remarkable vehicle, Mr. V. Zboril, of Bystrice, Moravia, has just perfected the first full-sized car on the same system.

So far from using driving wheels for its propulsion, the new vehicle, as represented in the accompanying figure, resorts to the use of a single pair of reciprocating legs. These strictly imitate the animal traction principle, though being superior to their prototype in so far as their pressure upon the soil is much firmer than that of a horse's hoofs. The circular motion of the driving crank is, by a suitable arrangement, converted into an horizontal reciprocating motion. The drive is simple, the wear and tear of the mechanism practically nil, while the lowermost or treading portions are readily exchangeable. As seen from the illustration, the vehicle comprises in front two wheels acted upon by the steering column. The fuel consumption is said to be very low, while the motion of the vehicle is absolutely uniform both in a forward and backward direction. The treading parts are resilient, and the vehicle, even when carrying heavy loads, will advance smoothly and easily. The speed corresponds to that of a galloping horse, though it can be raised to 70 kilometers per hour by lengthening the mechanical legs. The new vehicle, like other types of wheelless car, is mainly intended for traction on otherwise impracticable ground,

especially for agricultural purposes. While a wheel drive has to deal with all the obstacles found on the ground, the walking drive only strikes about 20 per cent of those actually existing.

The vehicle illustrated is a tractor weighing 680 kilograms and able to draw three wagons on rails. It will also draw a plow with three blades, fitted with runners so as to pass over the most impracticable ground. The mechanical legs move quite as smoothly as those of a living animal and readily pass over any obstacle that is encountered.

### Powerful Steam Fire and Salvage Boat

DURING the early period of the war there was under construction for the Calcutta Port Authority a fire and salvage boat especially designed for use in their docks and wareyards. At the outbreak of the war it was commandeered by the British Admiralty for the fire protection of the naval base on the Tyne, where it served its purpose so well that it was used subsequently for the protection of Boulogne Harbor, where the British government had enormous fire risks at stake on the conclusion of the armistice. Subsequently, it was used in the salvage of the block ships at Zeebrugge and Ostend, where the large capacity of its high-pres-



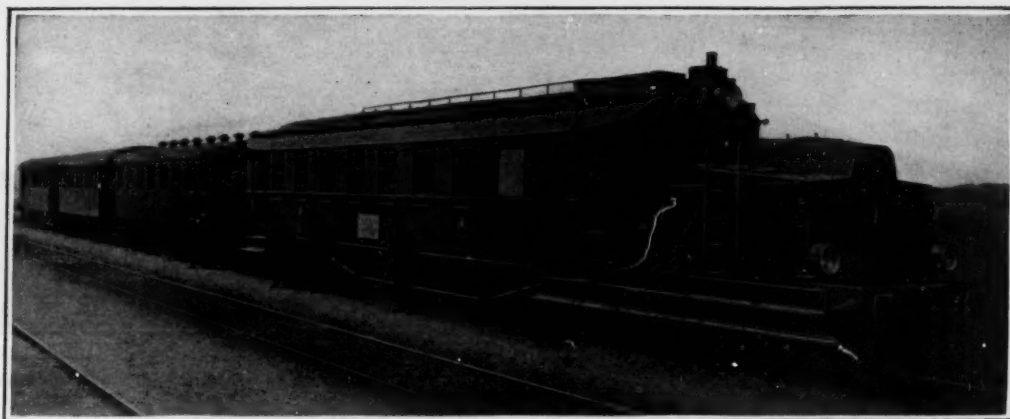
Test of a new fireboat at Calcutta in which 24 streams of water were thrown simultaneously into the air

height of 180 feet followed by single jets from 3-inch and 3½-inch nozzles which threw water to the same height. One of the trial tests was an interesting exhibition, in which 12 lines of hose were carried from the ship to the pier, where an equal number of streams were discharged. Our illustration shows the last test in which 24 streams of water were discharged simultaneously from the pier and from the ship itself.

### The Nature of the Nerve Impulse

WE owe to Lucas and Adrian the demonstration that, without any nerve-center whatever, an excised nerve-trunk with its muscle attached can be brought to yield, besides conduction of nerve impulses, the grading of them. That is remarkable, because the impulse is not gradable by grading the strength of the stimulus. The energy of the impulse comes not from the stimulus, but from the fiber itself. Lucas and Adrian have shown, however, that it is gradable in another way. Though the nerve impulse is a very brief affair—it lasts about one thousandths second at any one point of the nerve—it leaves behind it in the nerve-fiber a short phase during which the fiber cannot develop a second impulse. Then follows rapid but gradual recovery of the strength of impulse obtain-

able from the fiber. That recovery may swing past normal to supernormal before returning finally to the old resting state. Hence, by appropriately timing the arrival of a second impulse after a first that second impulse may be extinguished, reduced, increased or transmitted without alteration. This property of grading impulses promises a complete key to reflex action if taken along with one another. The nervous system, including its centers, consists of nothing but chains of cells and fibers. In these chains the junctions of the links appear to be points across which a large impulse can pass, though a weak one will fail. At these points the grading of impulses by the interference process just outlined can lead, therefore, to narrowing or widening their further distribution, much as in a railway system the traffic can be blocked or forwarded, condensed or scattered. Thus the distribution and quantity of the muscular effect can be regulated and shifted not only from one muscle to another, but in one and the same muscle it can be graded by adding to or subtracting from the number of fibers activated within that muscle. As pointed out by Professor Alexander Forbes, it may be, therefore, that the nerve impulse is the one and only reaction throughout the whole nervous system, central and peripheral—trains of impulses colliding and overrunning as they travel along the conductive network. In this may lie the secret of the coordination of reflexes. The nerve-center seems nothing more than a meeting-place of nerve fibers, its properties but those of impulses in combination. Fuller knowledge of the mechanism of the nervous impulse, many of the physical properties of which are now known—a reaction which can be studied in the simplest units of the nervous systems—thus leads to a view of nervous function throughout the system much simpler than formerly obtained.—Abstract from address by Professor C. S. Sherrington, before the British Association, Science, September 29, 1922.



Locomotive and coach in one: A Swiss 250-horsepower internal combustion engine drawing a train of cars at a surprisingly low operating cost

sure pumps enabled it to render real Trojan service.

The "Alpha," as it is called, a steel vessel 107 feet 6 inches in length, with a beam of 18 feet and a mean draft of 5 feet, was built by Merryweather of London. It is fitted with four watertight bulkheads. Steam is supplied by two horizontal marine water-tube boilers capable of raising steam to the working pressure of 160 pounds in about 15 minutes. There is an auxiliary heater for keeping the water warm at all times, so as to facilitate as quick a start as possible. The boat is driven by twin-screw compound engines of 525 indicated horsepower. The pumps are of the double cylinder, vertical, Greenwich type; two in number, each having a capacity of 2000 gallons per minute. Pump delivery fittings on deck consist of two delivery heads, each with six valved outlets for connection to fire hose, and there is also a powerful monitor branch pipe with universal motion.

The total pumping capacity of 4000 gallons enables a single 3½-inch jet to be thrown to a height of 200 feet, or any larger number of jets of equivalent area from hose of monitors. It should be mentioned that because of the emergency character of its work, whether in salvage or fire service, particular care was taken in constructing both vessel and equipment.

In a recent trial at Calcutta two large streams of water were thrown to a



This walking tractor gets over the roughest fields with ease and can haul wagons or agricultural implements about the farm



Fleet of 619 warships in the offing includes 24 battleships, 86 cruisers, 10 flotilla leaders, 276 destroyers, 116 submarines. Ships in the foreground are 18 British dreadnoughts that have been either broken up, or

**W**HEN the Washington Naval Limitation Treaty shall have become sufficiently a matter of history for mankind to see that document in its true prospective, it will stand out as one of the greatest achievements of constructive statesmanship in the upward climb of civilization to a high standard of international morality.

To those of us who understood the significance of the agitation over the naval problem of the Pacific, the situation in 1921 was full of menace. Of the three dominant naval powers, the United States, Japan and Great Britain, the first two were actually, though not confessedly, engaged in a contest of inordinately costly dreadnought construction; while Great Britain, taking heed of this,

was preparing to make a similar prodigious effort lest she be left behind in the race.

Such competition always has and ever will breed a spirit of suspicion. Suspicion begets fear; fear, in its turn, breeds war. The post-war naval competition was having this inevitable result; and the smoldering fires were being blown to a white heat by a sinister religious-political influence, which believed that by promoting strife in the Pacific, it would be possible to break up the solidarity which had been achieved among the Allies during the World War. It is not the purpose of the present article to enter into the political aspects of the Treaty, further than to point out that, apart from its splendid achievement in stopping a ruinous and hatred-breeding naval competition, the Treaty has led to the settlement of the Shantung dispute and the evacuation of this port by the Japanese, to the annulment of the Anglo-Japanese Treaty, and in fact to a complete slackening of the political tension throughout the Pacific. Nevertheless, even during the time when the delegates to the Washington Conference were framing the Treaty, and persistently ever

## Fulfilling The Washington Treaty Scrapping a Fleet of British Dreadnoughts

since, the sinister forces above referred to have persistently opposed the Treaty, and even today are insisting that not only has it failed to bring about an amicable feeling among the three nations concerned, but (and this is the point which the present article is written to deny) that none of the nations are fulfilling that part of the Treaty which calls for the breaking up of large portions of their existing fleets.

This effort to discredit the Treaty has been chiefly manifest in sundry dispatches sent from Washington to the daily press, in which the public was told that not only has none of the three principal naval powers concerned—the United States, Japan and Great Britain—gone very far in the matter of breaking up the warships designated for destruction by the Conference, but that a new era of competition has been started in those classes of light cruisers and other vessels of moderate displacement upon which no embargo was laid at Washington.

Because of the vast additions made to her navy during the war, in order to make certain of being able to keep the seas open for herself and her Allies, the largest task of ship-breaking naturally fell to Great Britain, and it has been noticeable that this anti-treaty propaganda has been particularly active in denying that Great Britain has made any serious effort to reduce her fleet to the 5-5-3 ratio set by the Conference.

Not only has the public been misinformed through the press, but on the floor of Congress there was noticeable the same disposition to deny that any material results have been achieved in the scrapping of ships. Thus, not very long ago the chairman of one of the naval sub-committees, in answer to a question in Congress as to what had been done, stated that he did not think any nation had destroyed any of its ships "although Great Britain has pos-

### British Warships Scrapped Since the Armistice

Between the Armistice, November 11, 1918, and December 16, 1922, the following vessels, after being dismantled and rendered incapable of any further war service, have been either destroyed or sold out of the navy to be broken up. The list includes the eighteen dreadnoughts that have been scrapped in accordance with the Washington Treaty:

Battleships (dreadnoughts and predreadnoughts).....	38
Battle cruisers (dreadnoughts).....	4
Cruisers (armored and unarmored).....	32
Light cruisers (high-speed scout cruisers).....	54
Flotilla leaders (31 to 34 knots speed).....	10
Destroyers (27 to 35 knots speed).....	275
Torpedo boats .....	95
Monitors (built during the war).....	20
Submarines .....	105
Aircraft carriers .....	4

In addition to the above, the following ships have been rendered incapable of further service and are now on the sale list, awaiting disposal:

Battleships .....	5
Cruisers .....	1
Light cruisers .....	1
Destroyers .....	2
Submarines .....	11

Total ships scrapped since Armistice..... 657





ships, 116 submarines, etc., which have been broken up, or disabled and sold out of the British Navy, since the Armistice either broken up, or disabled and sold, in agreement with the Washington Naval Treaty

## Washington Naval Treaty

### Dreadnoughts that Fought at Jutland

persisting in the belief that she had already begun to scrap before the Conference."

Our readers have but to take a glance at the picture at the top of this page to realize what a piece of inexcusable misinformation was thus being given to Congress and through Congress to the nation at large.

Again, in spite of the fact that one of the three powers alone has scrapped 18 dreadnoughts since the Treaty, let the reader take note of the following quotation from a dispatch from Washington which appeared recently in a leading New York daily paper: "Washington.—Neither the United States nor any other country signatory to the Washington Naval Limitation Treaty has begun the scrapping of warships provided for in that Treaty so far as the Washington Government is aware. It was said today at the Navy Department that the only aspect of the Treaty already brought into force was the suspension of new capital ship construction in the United States and Japan. The scrapping of warships, which has been proceeding in Great Britain, Japan and the United States, it was explained, has affected only vessels which are formally classified by each power as wholly obsolete for naval purposes."

In order to get at the truth regarding this matter the SCIENTIFIC AMERICAN applied directly to the authorities of the various navies concerned, and asked if they would furnish us with the conditions that existed at the beginning of the present year. The facts as regards the British navy were obtained for us by our London correspondent, Hector C. Bywater, who received them, on our behalf, from the British Admiralty. These authentic tables, as published herewith, show that so far from the British fulfillment of the Treaty having affected "only vessels which are formally classified by each power as wholly

obsolete for naval purposes," that power has actually scrapped no less than 18 dreadnoughts, all but one of which were in the first fighting line of the British at the great battle of Jutland.

How misleading is the statement that only vessels that are wholly obsolete for naval purposes have been scrapped is shown by a brief study of the accompanying

table of these 18 ships. Thus, we find that five of the ships carried the 13.5-inch gun, a piece that in our navy is considered to be approximately equal to our own 14-inch gun, which forms the primary armament of 11 of our first-line dreadnought battleships today. Among these destroyed warships is the "Princess Royal," a 28½-knot battle cruiser, carrying 13.5-inch guns, and sister to Admiral Beatty's flagship. Beatty's famous flagship, by the way, was also on the sale list; but when the British discovered that they were the only nation that was breaking up any dreadnoughts, they decided to withdraw the "Lion" until France and Italy had ratified the Treaty. Three other ships that have been scrapped (by scrapped we mean either broken up, or disabled and sold out of the navy) are the battle cruisers "New Zealand," "Indomitable," and "Inflexible," of 26 knots speed. Among the dreadnoughts are the "Erin," completed in 1914, carrying ten 13.5-inch guns, and the "Agincourt," finished in the same year, carrying fourteen 50-caliber 12-inch guns, and three other dreadnoughts, the "Orion," "Monarch," and "Conqueror," each mounting ten 13.5-

inch guns, and all completed in 1912. Additional to these there have been scrapped nine dreadnoughts mounting each ten 12-inch guns.

With the exception of the original "Dreadnought," completed in 1906, the ten dreadnoughts mounting 12-inch guns are in the same class as our "Utah," "Florida," (Continued on page 288)

British Dreadnoughts Broken Up or Sold Since the Washington Treaty

	Type	Guns	Displacement Tons	Completed
Princess Royal.	Battle cruiser	Eight 13.5"	27,250	1912
New Zealand...	"	Eight 12"	19,500	1912
Indomitable ...	"	Eight 12"	17,850	1909
Inflexible .....	"	Eight 12"	17,850	1909
Erin .....	Dread'nt b'ship	Ten 13.5"	23,800	1914
Orion .....	"	Ten 13.5"	23,300	1912
Monarch .....	"	Ten 13.5"	23,300	1912
Conqueror ....	"	Ten 13.5"	23,300	1912
Agincourt ....	"	Fourteen 12"	28,500	1914
Colossus .....	"	Ten 12"	20,750	1911
Hercules .....	"	Ten 12"	20,750	1911
Neptune .....	"	Ten 12"	20,750	1911
Collingwood ...	"	Ten 12"	19,900	1910
St. Vincent....	"	Ten 12"	19,900	1910
Superb .....	"	Ten 12"	19,900	1910
Temeraire ....	"	Ten 12"	19,250	1909
Bellerophon ...	"	Ten 12"	19,250	1909
Dreadnought*..	"	Ten 12"	18,500	1906

\*The above ships, with the exception of the original "Dreadnought," formed over one-half of the first battle line at the battle of Jutland.

†"Monarch" has been rendered ineffective for war purposes (as per Treaty), and is being used for experimental purposes.

# Harnessing California's Waters

## The Completion of the First Stage of the Pit River Power Project

By Charles W. Geiger

**C**ALIFORNIA is now the greatest hydro-electric power State in the Union. Over one-fifth of all the electric power generated by American water is produced in California. Last year, according to figures announced by Engineer H. D. McGlashan of the water resources branch of the United States Geological Survey, 3,227,262,000 kilowatt-hours were produced by water power in California. New York, which comes next with 14.72 per cent of the total, made 2,203,564,000 kilowatt-hours.

On Saturday, September 30, 1922, an important step in California's electrification was carried out. On this date the constantly flowing waters of the Fall River were diverted through a tunnel and dropped 454 feet through steel penstocks to the Pit River Power Plant No. 1. From this tremendous force of falling water there is now being generated 93,000 horsepower available for use in the factories, on the farms and in the homes of the State. When the two 46,500-horsepower electric generators began to function, they signaled the completion of the first big unit of power development along the Pit River in which one hundred million dollars will ultimately be invested.

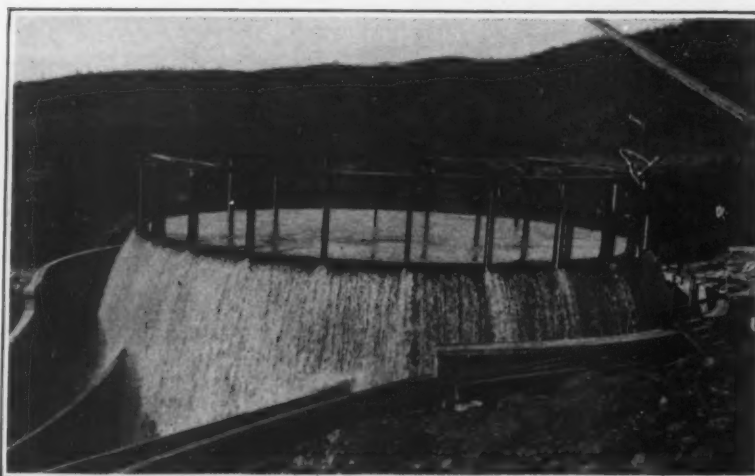
The power of the Pit River plant is carried over a transmission line more than 200 miles in length, and the substation at which it is received is the first to be constructed anywhere in the world for 220,000 volt operation. Thus another victory is recorded to the credit of the company which has pioneered the way in hydro-electric generation and in long-distance transmission of power. It was this company which accomplished the "impossible" in 1895, by constructing the first long-distance transmission line in the world—from a power plant at Folsom to a substation in Sacramento, a distance of 20 miles.

The importance of Pit River Power Plant No. 1 is in itself great, yet it is but the beginning of the Pit River project. The whole development will not reach completion until 1935 and the total cost (as stated previously) will be \$100,000,000. This means an average yearly expenditure of nearly \$8,000,000.

The history of the work dates back to 1917, when the company purchased the properties of a smaller concern whose activities were centered upon a hydroelectric project on Pit River at Big Bend. The purchasing company undertook at first to complete this, but conditions arose which brought about change in plans.

A succession of dry years had almost dried up the Sierra streams, and it was necessary that the company find additional power on short notice. So the Big Bend project was abandoned for the time being and a move was made farther up stream, which would enable the immediate construction of two preliminary plants in Hat Creek, and a chain of developments on the Pit River, leaving the Big Bend as the last link of the chain. The Hat Creek plants were placed in full operation in September, 1921.

Meanwhile plans were laid out for construction of the first development on the Pit River. It was decided to divert the waters of Fall River about a mile above all River Mills, which marks that river's junction with the Pit, and by means of a



The novel surge-chamber in full operation

tunnel approximately two miles in length, convey the water through the intervening hillside to a point in the Pit River Canyon 454 feet above the stream, on the bank of which was marked the site for a power house

cities around the San Francisco Bay for one year, and still leave a surplus.

This was the big job, the completion of which was celebrated on September 30 last. It involved the construction of a diversion dam on Fall River 500 feet in length from which an intake canal 1000 feet long carries the water to the east portal of the tunnel. One year was required for boring the two-mile tunnel.

As is the case with all big projects, difficulties were encountered in the construction of Pit No. 1 plant and one of these was the transportation problem. It was found that the roads were practically impassable seven months of the year because of snow and mud, so it was decided to build a railroad. This road, a continuation of the McCloud River Railroad at Bartle to the scene of construction, a distance of 33½ miles, was built in three months.

The project also included a double-circuit transmission line to carry the electric energy of the Pit to the company's new sub-station near Vacaville. At this station connection is made with the comprehensive electrical distributing system by which the company now places 595,000 horsepower in installed capacity at the disposal of its consumers.

The substation building houses two 20,000-kilovolt-ampere synchronous condensers whose business it is to regulate the voltage of the power received from the Pit. The main transformers, high tension oil and air switches and high tension busses are installed outdoors. Seven 16,667 kilovolt-ampere transformers are required to reduce the voltage of the power received from 220,000 to 110,000 for retransmission to other distributing substations serving principally the cities and regions bordering San Francisco Bay.

The transmission problem, involving the conveyance of electrical energy an unusually long distance without

serious loss, was at first regarded as a stumbling block in the way of Pit River development work. Now, at 220,000 volts a maximum of 140,000 horsepower can be transmitted 200 miles with an 8 per cent loss.

Below Pit No. 1 the four developments needed to complete the chain have been tentatively outlined as follows:

Pit No. 2 project begins about a mile down stream from the other, and will consist of a diversion dam, outlet tunnel, two and a half miles of open canal spillway and header box, penstock, power house and tail race. Here the installed generating capacity will be 23,500 horsepower.

Pit No. 3 development is located below Peck's Bridge, where a diversion dam 100 feet high will create a reservoir of about 32,500 acre-feet capacity, from which a tunnel nearly four miles in length will be constructed. The installed capacity here will be 90,500 horsepower.

Pit No. 4 will be similar in layout to No. 3. Two miles below its predecessor a pressure tunnel from three to four miles in length will lead directly from a diversion dam and reservoir to the surge chamber, penstock and power house, where the installed capacity will be 107,200 horsepower.

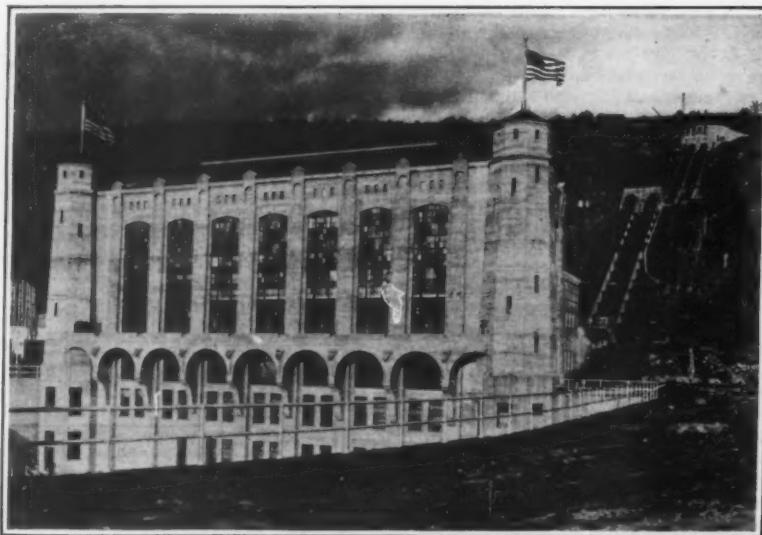
Pit No. 5, the Big Bend project, will be the largest of all. The installed capacity will be 253,600 horsepower.



At the left of this view is seen the largest butterfly valve in the world

with generators of 93,000 horsepower rated capacity.

Incidentally, the flow of water at the junction of the Fall and Pit Rivers is more than a billion gallons a day, meaning that one month's flow would be sufficient to supply San Francisco, Oakland and the other



General view of power plant, penstock and surge chamber

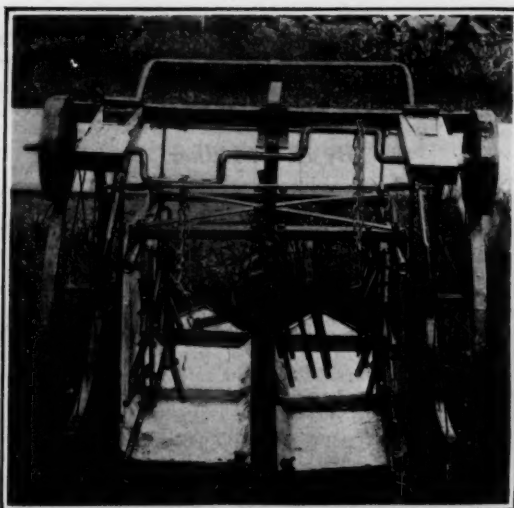


### Some New Wrinkles in Agricultural Machinery

IN no field does the inventor find a wider variety of problems, each permitting a wider variety of solutions, than in that of agriculture. The business of crop farming and of animal husbandry presents an enormous number of things which must be done by mechanical apparatus of some sort; and these things are almost all of such character that they may be done in numerous different ways. Convention, in many instances, has dictated the particular way in which they are to be done; but even here, the bold inventor, whether successfully or not is not pertinent to the argument, frequently steps out upon uncharted ground and devises new ways of attacking the job that are of extreme interest on the mere ground of their mechanical features.

Perhaps plowing is the aspect of farming that attracts the most attention from ingenious inventors. It is true that the old-fashioned plow, substantially the same as was used in Rome 3000 years ago, is not a particularly efficient instrument. But it has not been easy to devise a substitute that would escape from the weaknesses of the conventional plow without introducing a fresh crop of weaknesses all its own. One of the most suggestive attempts to do this which we have seen is that covered by the two photographs at the center of the page.

This plow was developed in France, and is a product of the intensive period of agricultural restoration that followed the armistice. For the usual plowshare is substituted the battery of hooks so well shown in the right-hand picture. The idea is that plowing with this apparatus will give the same result on large fields that



The bugs are brushed off the plants by the oscillating, waving springs; and they fall into a kerosene bath in the trays below

#### Picking bugs by machine

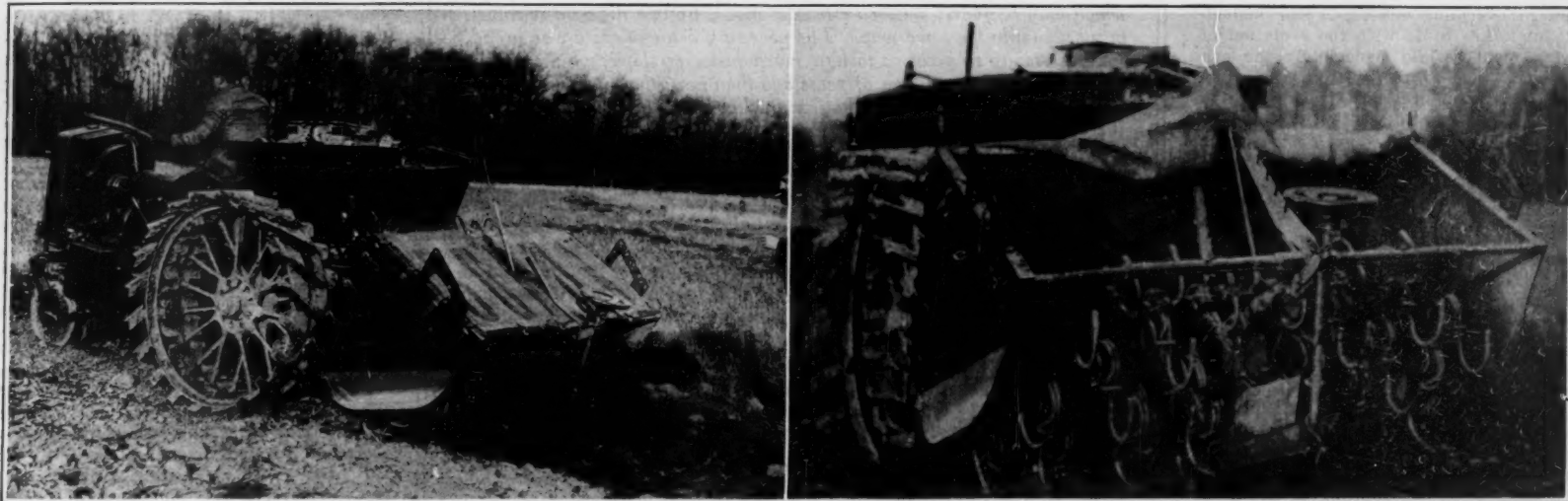
a deal more convenient for the farmer to do his subsequent work on a level surface.

If the inventor is able to suggest new ways of doing old things, however, he is equally able to indicate things that have never before been done and to suggest ways of doing them. As evidence of this, we have the apparatus illustrated at the top of

wheelbarrow, by man-power; the larger one will be power-driven. Both machines will roll on two wheels, like cultivator wheels. At the bottom are two metal troughs, which may be raised or lowered at will, while the opening between them may be widened to correspond with the width of the row. At the top are two wheels attached to an iron bar. These are revolved by contact with the wheels on which the machine moves. The bar, operated by these secondary wheels, gently oscillates a number of vertical and horizontal springs, near the bottom of the machine. These brush the insects off the plants into the metal troughs; and on falling into the latter, the pests find themselves in a bath of kerosene, which quickly terminates their careers.

Our photograph affords a necessary supplement to this description, indicating the manner in which the springs are mounted, etc. It will be seen that they are ordinary coil springs, rather tightly wound, and of considerable length. Hanging at various angles, with one end free, these springs are relied upon to sweep the plants comparatively clear of their parasites.

Our third and final picture herewith shows another appeal to the pocket-book of the potato farmer. It is a new type of digger, designed to bring the spuds to the surface with a minimum of time and labor. It does away with more than three-quarters of the moving parts to be found in the conventional potato-harvester. It consists mainly of a reversible plow and a set of six-foot wheels, built with a simple series of connecting spindles. The potatoes are excavated by the plow, and by it thrown into the revolving spindle-wheel, where they are gradually shifted toward the outer rim, to drop off in a long row as the digger progresses. Diagonal braces within the wheels serve the function which



General view of the new French improvement upon the plow, with close-up of the part of the machine that does the work

hand spading gives in the garden, loosening and aerating the soil in a single operation so effectively that further harrowing is not necessary. The hooks can be set to plow to any desired depth from two to twelve inches, and in wet or dry or even flinty soil. At the same time, if the plowing be preceded by a surface application of manure, chemical fertilizers, ashes, sand, marl, stubble, etc., a very thorough incorporation of these is secured during the plowing. The tractor element of the machine is of considerable power, and will work effectively in ground of any reasonable character and on any grade up to 15 per cent. The plow roller can be dismounted and the machine used as a tractor with some other apparatus, the tractive effort exerted being in the neighborhood of 2000 pounds. A smaller type of this "mote-culteur," as it is called by its manufacturers, is available for garden purposes.

It will be understood that this substitute for the plow does not make a furrow. On the contrary, it pulverizes and mixes the ground thoroughly, and replaces it in a smooth surface. For most purposes, this is really preferable to the furrowed surface, provided it be assured that the granulation, aeration, etc., are thorough. There seems really no reason, other than long custom, why the process of preparing soil for crops should leave a surface resembling the Channel in stormy weather. Save when seed is to be planted which requires a very deep back-covering, it is

the page—a machine invented by A. Bridgen, of Birmingham, Ala., for the extermination of the potato and bean bug and, the inventor hopes, even the boll weevil. The machine has been given all necessary tests, and it is expected to put it on the market this spring.

Two sizes of this device are to be manufactured, a small one for potato and bean bugs and a larger one for the boll weevil. The small machine is pushed like a

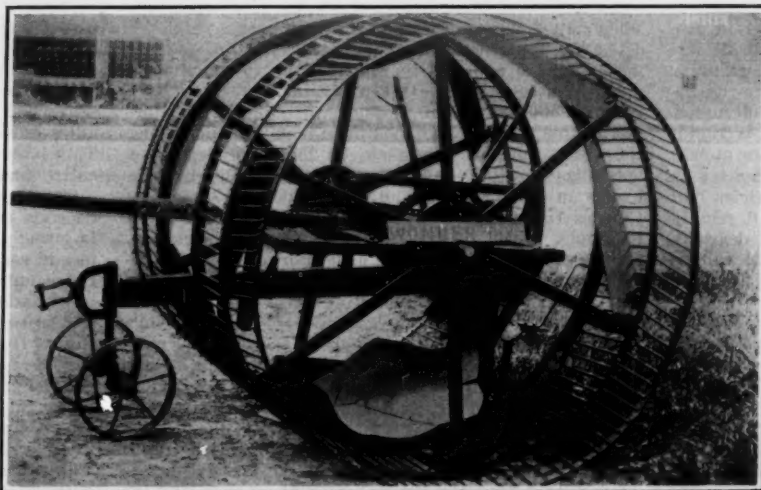
their name suggests, and in the bargain accelerate the movement of the potatoes toward the outer edge. Only one team is required to operate the digger in any kind of soil according to the claims of the inventor.

#### Dry Cell Specifications

THE Bureau of Standards has issued specifications for the standard sizes of dry cells and flashlight batteries. These specifications are a revision of similar specifications prepared several years ago, and published in the first edition of Circular No. 79, on the electrical characteristics and testing of dry cells. In revising these specifications the Bureau has received the hearty cooperation of the leading manufacturers and some of the largest individual users of dry cells. Special mention is made of the cooperation received from the American Telephone and Telegraph Company and the signal section of the American Railway Association.

Before beginning the revision of the specifications a conference was called which met at the Bureau of Standards, to which the manufacturers, various government departments, and a few of the largest individual users were invited to send representatives. Thus the best knowledge in dry battery technique was assembled.

A limited number of copies of the new specifications is available for distribution prior to publication of the second edition of the dry cell circular now in press.



Potato harvester that eliminates more than three-quarters of the moving parts found in older machines

# Concerning the Age of the Earth

Some of the Methods of Estimate that Have Been Used, and the Results that Have Been Obtained

By H. V. Hilker



WHEN contemplating the earth in its relation to time, we might consider its birth as coincident with the first accretion or in-falling of particles from the planetesimal nebula. But this first nucleus was not a planet nor can it be considered as such until all or nearly all of the nebulous material had concentrated into a single whole. (Saturn is here excepted as an unusual condition.) During this process of accretion, an enormous amount of heat was generated by the gravitational pull on the outer surface which resulted in local liquefaction of the rock mass and its consequent outpouring in the form of vast lava flows.

Up to this time the earth was in the embryonic or formative state. Therefore, let us consider its birth as the time at which these lava flows cooled to a sufficiently low temperature to allow the surrounding envelope of vapor to condense and fall upon the earth more or less as what we know as rain.

The question of age then, in the sense we shall use it, may be approached from three distinct angles. The physical angle takes into consideration the rate of cooling, internal heat due to pressure, tidal stability, and the disintegration of certain rock-forming minerals. The biological angle has to do with the evolution of living forms, while geologically the evidence is taken directly from the earth itself—its structure, the stratification of the rocks, and the deposition of the sediments.

In 1862 Lord Kelvin, applying Fourier's theory of thermal conductivity, came to the conclusion that superficial consolidation must have occurred not less than 20,000,000 years ago, otherwise the underground heat would be far greater than it really is. Furthermore, he believed that had the earth solidified more than 400,000,000 years ago, little increase in temperature would now be noted as the center is approached. With these two figures as extremes and giving the lesser somewhat the benefit of the doubt, he took 98,000,000 years as a mean, giving this as the age of the earth. Later, King and Barus pointed out that owing to the friction of the tidal wave, the rotation of the earth is retarded and therefore slower now, than the earth's infancy. Influenced by these calculations, Kelvin in 1897 reduced the greater figure of this estimate to 40,000,000 years.

The discovery of radium in 1896 by Mme. Curie and the subsequent work of Becquerel, Rutherford, Strutt, and others in radioactivity threw a new light upon the working of natural forces. This led to an attempt at calculating the age of certain rocks and minerals by their helium content. Now it is well known that radium is a disintegration product of uranium, brought about by the radiation of  $\alpha$  particles. During this decay, uranium changes to radium with uranium  $\alpha$  and ionium as intermediate products, and thence through radium A, B, C, D, E, F, and to radium G. This last is radiolead and differs from ordinary lead only in its atomic weight, which is less. As each of these changes is accomplished by expelling one or more  $\alpha$  particles and as an  $\alpha$  particle is an atom of helium, it will readily be seen that the sum of the helium and the degradation product contained in any rock or mineral will be the original amount of the parent element uranium. Given then these two factors and the rate of generation of helium, which is fairly well known, the age of the rock is easily calculated. Taking this method, Rutherford found the age of a certain fergusonite to be something over 500,000,000 years. Joly, taking a different rate of decay from uranium, changed this estimate to 241,000,000 years. In the same way, Strutt found the age of Ceylon thorianite to be 280,000,000 years and that of a Canadian sphene to be 710,000,000 years. He also placed the age of hematites from the Carboniferous and the Eocene at 150,000,000 and 31,-

000,000 years respectively; while he gave a figure of 225,000 years for certain phosphate modules. The figures arrived at by this method of calculation seem to follow approximately the geological order, the larger figures being given for the older formations. Large as these figures may seem, however, the ages given for some minerals are still more startling, as for instance fergusonite at 10,350,000,000 years and yttrialite 11,470,000,000 years. It may be said further that these figures are believed to be minima, as some helium may have escaped. In the SCIENTIFIC AMERICAN for June 4, 1921, Russell presents perhaps the most careful collation of all this material that has been made, and concludes that the earth is somewhere between one and eight billion years old. Our drawing discounts this minimum, for safety's sake.

The biological angle of our problem is by far the most narrow, yet a certain amount of attention must be given it in order to appreciate the vast changes that have been wrought in life forms during the past ages.

*JUST as there is no definite limit to human ingenuity, so there is none to the different ways in which the approximate age of the world may be estimated. Nor is there any to the degree of divergence which may be found between estimates made, by two different scientists, in substantially the same way. The necessary assumptions are so broad, the uncertainty so great as to how much faster or slower physical processes may have run millions of years ago than now, that no calculation of the earth's age can be more than an intelligent guess. Indeed, many of the calculators emphasize this by giving upper and lower limits, which are often very far apart.*

*Regardless of just how much numerical precision may attach to any given estimate, it is fair to say that all estimates make the earth millions of years old. It is again fair to say that all of them are interesting, alike for the method employed and for the result attained. So we have permitted Mr. Hilker to set down the accompanying summary of the eminent scientists who have attacked the problem, the methods of attack which they have employed, and the results which they have attained; and we have got our artist to give to the story the graphical form of the facing page. In the bargain, we summarize here some of the more significant estimates that have been made:*

Date	Name	Method	Maximum in Millions of Years	Minimum
1862	Kelvin	Temperature	400	20
1897	Kelvin	Temperature and Tides	40	20
1896	Poulton	Biological	400	400
1860	Phillips	Sedimentation	96	38
1899	Gajke	Sedimentation	400	100
1909	Sollas	Sedimentation	80	34
1899	Joly	Salt in Ocean	100	80
1909	Sollas	Salt in Ocean	150	80
1910-15	Becker	Salt in Ocean	100	50
1921	Russell	Radioactivity	8,000	1,000

When we compare the single-celled ameba with the delicately constructed and brilliantly colored sea-anemone, we are appalled by the thought of the time it must, of necessity, have taken for the latter to evolve from a shapeless bit of protoplasm similar to the former. How then may we look upon man without feeling the significance of this factor? The high degree of specialization that had been reached by the invertebrates in the pre-Cambrian life-period was noted by Charles Darwin as early as 1859, and he demanded an enormous period of time to bring about this change. In 1869 Thomas Huxley also asked for a very long pre-Cambrian life-period, and this demand was renewed in 1896, when Poulton, in computing the earth's age from a biological point of view, even considered Lord Kelvin's original maximum figure of 400,000,000 years as none too long; while G. H. Darwin went so far as to ask that this be multiplied by a number from 15 to 20. It would seem, however, that some of these figures are unnecessarily large.

Turning now to geology, we must look to the earth itself for an answer. For it is in the massive layers of rock that form the lithosphere that we may find the record of the past. When the earth had sufficiently

cooled to retain the water which condensed above and fell upon it, streams formed and began to flow. Here, then was the beginning of erosion, the wearing away of the land by the water and the carrying of material from the high lands to deposit it in the valleys beyond. Here too, was the beginning of the ocean. As time passed, the accumulation of sediment upon the ocean floor grew to a great depth. The chemical action of the minerals in solution, aided by the enormous pressure of its own volume, solidified the sediment and the result was rock. Then came a catastrophe. The warping of the earth's crust caused upheavals of the land. In some places the floor of the ocean was lifted high above the former water level, while parts of the land down-warped into great declivities or synclines. It must be understood, however, that these changes did not take place in a short time. On the contrary, they were of age-long duration. Meanwhile, erosion kept up its work. The newly born valleys became the ocean and inland seas, while the one-time ocean bed was carried away by the wind and the water to be redeposited in other places. Thus, we see that the land of today was sea of yesterday and what is today the sea may sometime become dry land.

Each stratum of rock, therefore, was at one time deposited from a body of water, and its relative thickness is an index to the length of time consumed in the process. Here and there we find a stratum that has not been deposited in this manner, but as these are mostly igneous intrusions and lava flows with more or less volcanic dust and loess deposits, they have little bearing on the problem at hand. We must keep in mind, too, that any stratum of rock we measure is only that part of the original mass which has not been eroded away. Great erosion, however, is usually indicated by a marked non-conformity to the rock above, either in the character of the rock itself or in the contained fossils.

Of the primordial rock, the rock formed by the solidification of the original molten magma, we know little. But this lack of knowledge is of no moment here, as our calculations begin only after this rock has become cold. We must therefore turn our attention to the succeeding strata of sedimentary rock, the thickness of which must indicate the time required for their information. It is not necessary to catalogue the various strata with regard to thickness, as this would only tend to entangle a problem already too complex. The first great formation then with which we have to deal is the Archeozoic. Here the Grenville series alone has a thickness of over 94,000 feet. Immediately following this in the geological scale are the early and late Proterozoic suberas, of which there is upward of 37,000 feet each exposed in the Rocky Mountain region. The seven periods of the Paleozoic, of which the Cambrian is the oldest, have a varying thickness of from 10,000 to 30,000 feet, while the strata of the succeeding ages are somewhat under these figures. In all, there are 64 miles of sediment resting upon the basement complex. This is equivalent to a layer 2300 feet thick over the entire surface of the earth.

The time required to form a given thickness of rock depends largely upon the rate at which the sediment is brought down by the streams. This rate is by no means constant, but is determined by the character of the country through which the various streams flow, by the slope of the land, by the annual rainfall, and numerous other factors. Data compiled by the United States Geological Survey for all rivers emptying into the ocean give the total amount of material carried in solution annually as 2,735,000,000 tons. By deducting from this the percentage of the more soluble salts which are held in solution, and converting the remainder into its equivalent volume of solid rock, John Phillips in 1860 placed the age of the earth somewhere between 38,000,000 and 96,000,000 years. Computing the time in this same manner, De Lapparent has given



67,000,000 years and 90,000,000 years as a minimum and maximum duration of the pre-Cambrian time and 27,640,000 years as that which followed, while Sollas in 1909 put the extremes at 34,000,000 and 80,000,000 years.

These last considerations, dealing with erosion by chemical denudation and the formation of the ocean, bring us to a second phase of the geological angle. This is the calculation of the age of the ocean, which, as already has been seen, must be the same as that of the land. Over two hundred years ago (in 1715), Edmund Halley pointed out that, assuming a primitive fresh water ocean, the amount of salt now contained would be an index to its age, could sufficient data be had. As these data were not obtainable until within the past few years, it remained for such men as Joly, Sollas, Clark and others to attempt an answer. Roughly, the following are the figures used by them. The total volume of the ocean taken as an average of that given by Murray and Karstens is 302,000,000 cubic miles. The weight of sodium in solution is  $14,130 \times 10^{12}$  tons, with 158,357,000 tons added annually by the rivers. By the use of the formula

Na in ocean

= age of ocean

Annual Na in rivers

J. Joly in 1899 placed the ocean's age at 97,600,000 years. Joly, however, failed to take three important factors into consideration; namely, cyclic salt, salt of human agencies and submarine salt. Cyclic salt is that which is lifted into the air by spray from the waves, carried inland by the winds and dropped, later to be returned by the rivers. The value of this is placed at six per cent. The salt of human agencies, that is, mining and chemical industries, is placed at four per cent, while that extracted from the floor of the ocean is about one per cent. By using these factors for correction of Joly's figures, Becker made the equation.

$$14,130 \times 10^{12}$$

$$= 89,222,900$$

158,357  $\times 10^6$   
A fourth and very important factor working in the opposite direction must also be taken into consideration. Four-fifths of the surface rock of the earth is sedimentary, and each cycle of erosion and redeposit has further leached out its sodium. It is reasonable to suppose then, that as time passed, the amount of sodium delivered to the ocean grew less. This is borne out by the fact that while the amount of chlorine in the ocean is greater than that of the other acid radicals, just the reverse is true of the combined waters of the rivers. Clark has aptly shown this relation thus: in ocean  $\text{Cl} > \text{SO}_4 > \text{CO}_2$ , while in river water  $\text{CO}_2 > \text{SO}_4 > \text{Cl}$ . Taking this extraction or leaching-out process into consideration, Becker in 1915 placed the age of the ocean—and therefore of the earth—at somewhere between 60,000,000 and 100,000,000 years.

Our lack of knowledge concerning the interior of the earth, both as to its chemical composition and its physical state, is one of the most serious obstacles in the way of ascertaining its age. In accepting King's figures for tidal stability, Lord Kelvin based his calculations upon the melting point of diabase. Now, while we cannot dispute the assumption that diabase forms the basement complex, we know that there is an

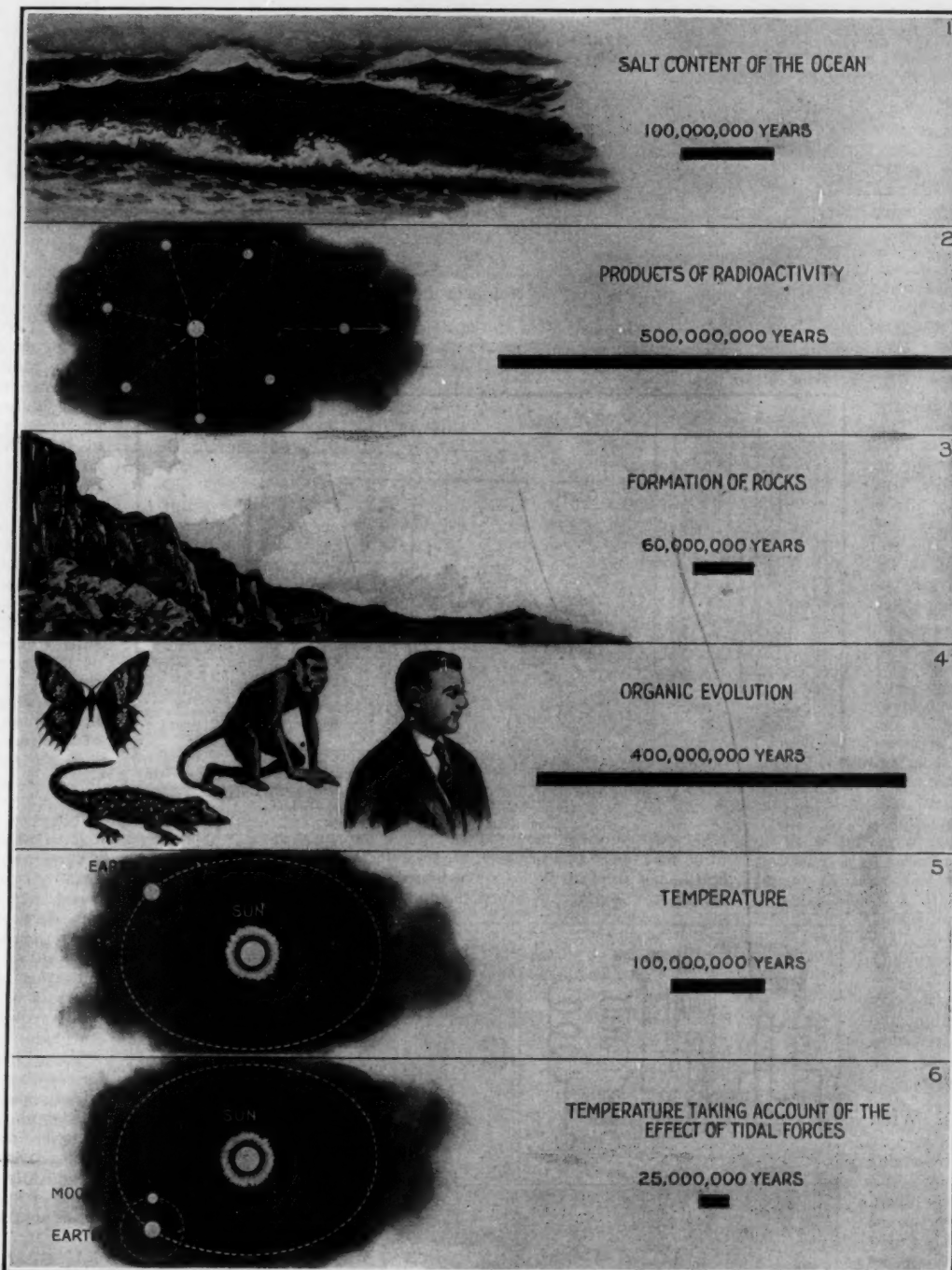
overlying couch of material, ranging in thickness from 34 miles to 64 miles, which has a melting point much higher. Again, Kelvin was in error when he accepted the temperature gradient of 1 degree Fahrenheit in 50.6 feet as universal. The work of Koenigsburger, whose data were taken from 28 nearly level inland regions in chemically unaltered rock, showed a variation in gradient from 1 degree Fahrenheit in 42.4 feet to 1 degree Fahrenheit in 60.3 feet. It would appear from all these considerations that Lord Kelvin's maximum figure of forty million years for the apparent geological age of the earth is somewhat low.

activity or the atomic disintegration of uranium are entirely out of accord with those resulting from other methods of computation, there are other reasons that lead us to believe them to be in error. Helium does not necessarily occur with uranium. Strutt found it in considerable quantities in beryls containing no radioactive parent whatever. Furthermore, while helium is plainly seen in the solar spectrum, P. G. Nutting failed to discover uranium, thorium or radium even in a 30-foot reproduction of it. Helium is present in the nebulae and hotter stars, but so far they have failed to show any trace of the radio-active elements. Again,

17,845 liters of helium are brought to the surface of the earth each year by a spring in Santenay, France. This, if derived from radioactive decay, would require 500,000,000 metric tons of pitchblend. G. F. Becker in 1914 brought strong arguments against this method of computation.

A glance at the table below will suffice to show that the only concordant results are in the figures taken from geological data, either by measurement of the sedimentary deposits or by the sodium chloride content of the ocean. While stratigraphy as a means of measuring time is of the highest value, it cannot be regarded as infallible. Certain conditions may have existed when the earth was young which make the most careful of calculations worthless. Moist and arid climates are easily distinguished in the later geological periods by their fossil fauna and flora; but during the ages previous to the carboniferous a deduction of this kind is difficult to say the least, if not impossible. How, then, shall we say that the annual sedimentation during the pre-Cambrian was great or little? To bring the problem of sedimentation down to our own age, we may cite the incident of the peat bog in Germany. According to figures based upon the rate of deposition, this bog is 18,000 years old. As a matter of fact, coins were found in the base of it, bearing the stamp of Claudius Caesar!

The point of greatest uncertainty in calculations based upon stratigraphical data is the pre-Cambrian. The rather primitive types of animal life found in the basal Cambrian rocks prove that evolution had been in progress long before this time. In the chronological scale, Walcott places the base of the Cambrian roughly at about the middle of the earth's history and suggests 27,640,000 years as the time which has elapsed since its formation.



A few of the more important estimates of the earth's age, shown graphically. The heavy lines in the several figures are proportional to the number of years called for by the respective estimates

Regarding Darwin's and Huxley's demand for a vast amount of time necessary to bring about the changes in life forms, it may be said that this was because they saw evolution in the light of natural selection only. Recent theories of orthogenesis would tend to reduce this time very materially. This fact has been shown by Hugo de Vries, who in ten years brought about changes in the evening primrose which through natural selection alone might have required tenfold that length of time. On the other hand, certain animal forms, such as *Lingula*, have persisted almost without change from the base of the Cambrian onward. The foundation in known fact is weaker in the biological estimate than in any of the others.

Aside from the fact that figures based on radio-

### Getting Gasoline from Coal

AN account of the discovery of a process for producing gasoline from coal was recently given by Dr. Friedrich Bergius to the Birmingham University Mining Society. It was stated that experiments with this process have been successful at Mannheim, Germany, where a plant with a capacity of sixty tons per day has been installed. The conversion of coal into petroleum is said to be achieved by introducing hydrogen into the coal, thus completely changing its chemical character and converting about 90 per cent of it into a liquid similar to fuel oil. This oil by another process is then transformed into light oils (twenty per cent by volume of the fuel oil treated), gasoline (forty per cent) and Diesel-engine oil (forty per cent).

### Something New in Tubes: The Donle Non-Interfering Detector

AFTER several years of careful and constant experimentation on detector tubes of various kinds, Harold P. Donle, chief engineer of the Connecticut Telephone and Electric Company of Meriden, Conn., has developed a new detector of promise. This new tube is claimed to have none of the disadvantages of regenerative and gaseous detector systems now in use, while its method of operation seems to involve many interesting phenomena which are radically different from those occurring in other tubes.

Referring to the accompanying schematic presentation of the tube, it will be noted that *F* is the filament, *A* the anode, which may be of metallic sodium in the bottom of the tube, and *H* is the heater in the shape of a short length of resistance wire cemented to the outside of the glass, directly underneath the anode. This heater maintains the anode at proper operating temperature. *C* is the "collector" electrode of sheet metal bent into a U and positioned above the filament with its open side toward the anode.

In operating the Donle tube, which is shown connected in a simple two-circuit tuner arrangement, one terminal of the secondary is connected to the collector

electrode and the other to a contact operating on resistance connected directly across the filament battery terminals. The remainder of the circuit is as used with any simple detector. The adjustment of the collector potential is the only one necessary for efficient operation other than the usual variation of capacity and coupling of the tuning circuit. The potential of the "B" battery is not at all critical and usually may be varied between 10 and 30 volts without much effect on response.

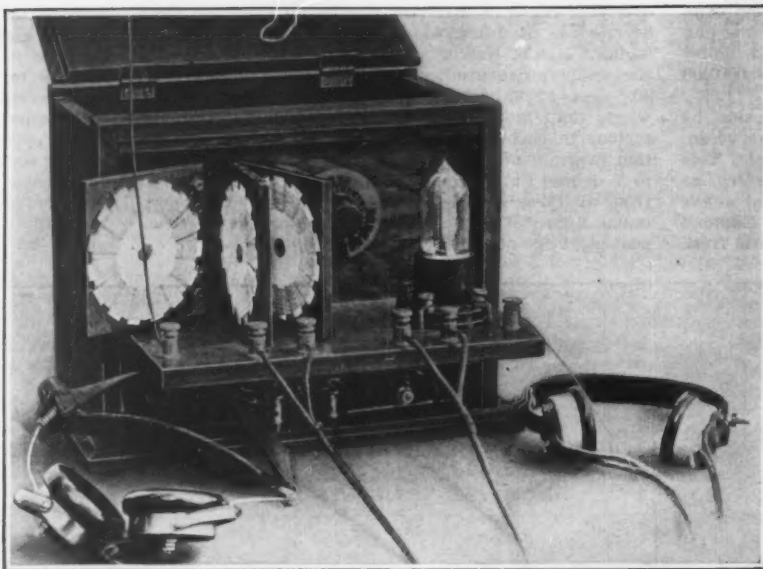
As a detector, this device is remarkably sensitive. Its adjustment is simple, and it is absolutely stable in operation. The response secured with this tube in a plain circuit is said to equal in magnitude the response from a regenerative arrangement, using maximum non-oscillating regeneration. A regenerative circuit under this condition of critical adjustment will give very considerable distortion, which is particularly objectionable when receiving voice or music, and which can only be eliminated by a reduction of regeneration and consequent reduction of signal strength, especially noticeable with a loud-speaker.

The new detector creates no noticeable distortion, and as it does not oscillate over its useful range, it cannot create any interference with other receivers. Furthermore, it is unaffected by small capacity changes, such as those produced by the operator's hand in tuning. The response of the tube is greatly improved by very weak coupling between the circuits.

### Radio Simplicity Combined With Radio Efficiency

THAT the efficiency of a radio receiving set is not necessarily caused by a formidable array of instruments is again proved by the simple outfit shown in the accompanying illustration. Here is a neat and compact regenerative receiving set which may be readily carried about in its small case. Indeed, the size of the entire set is 7 by 9 by 11 inches, when closed up for carrying.

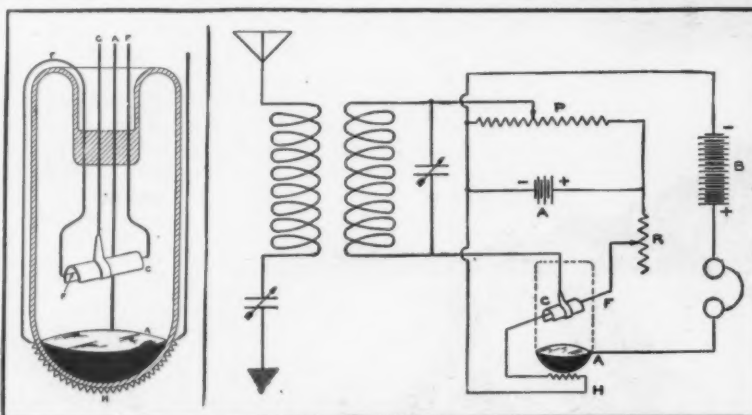
To prepare the set for operation, a small shelf, carrying the tuning elements, rheostat and tube, is drawn out as shown in our photograph, until the top of the panel hits a cleat which arrests further progress, and the lower part rests against shoulders on the side supports where the contacts for the filament or "A" battery are mounted. Thus the panel is held firmly in place by its own weight, at the same time lighting the filament of the tube. The "B" or plate battery is snapped into the circuit at the back of the board, and the antenna, ground, and either one or two pairs of 'phones are connected to



Simple receiving set for long-distance reception

the posts on the front of the upright instrument board. The tuning elements involve the well-known "spider-web" coils. The center coil is stationary, while the

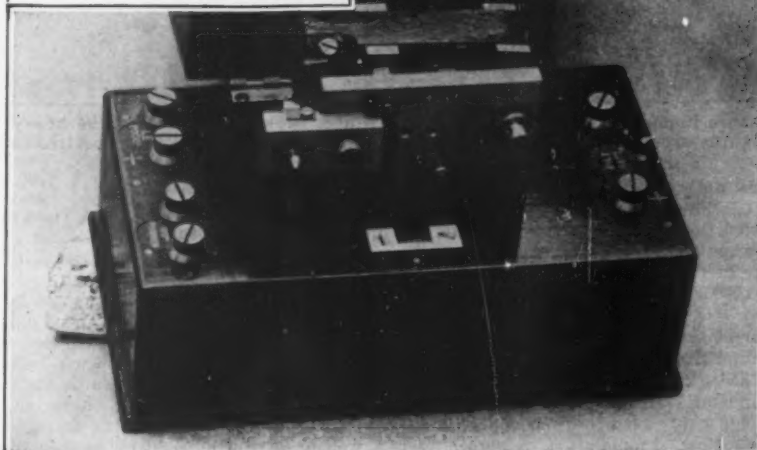
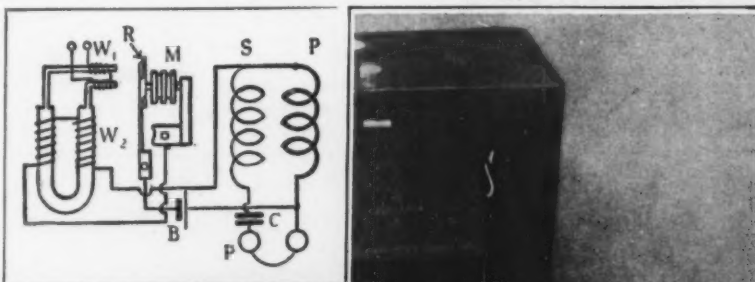
noted that the current from the crystal detector, which is normally brought to the telephone receivers, is in this case led to the winding *W* 1, which forms part of an electromagnet, the latter being made



Schematic presentation of the new Donle tube and its arrangement in a simple two-circuit receiver

other two coils are mounted on hinged supports so as to be movable. One of the movable coils, acting on the stationary coil, serves as a variometer for the tuning of the set, while the other movable coil, also acting

vibrating reed *R* is intimately connected with the microphone, any variation which it undergoes will be faithfully transmitted to the microphone. This action of the microphone, which is highly sensitive, modifies the current flowing through the circuit with corresponding change in the flux density of the telephone receiver. The vibrations of the reed *R* are affected by the pull of the magnet, the flux of which is increased by the flow of the current through the windings *W* 2. Thus, the fluctuating current from the microphone is repeated back and remagnified. These strengthened impulses are passed through a step-up transformer, and the amplified signals are reproduced in the low resistance telephones. An amplification, practically equivalent to a single step of audio frequency with a vacuum tube, is thus obtained.



Brown microphonic relay for amplifying crystal detector signals from twenty to thirty times

on the stationary coil, serves as the regenerative control. The operation is quite simple, yet remarkable tuning can be obtained despite the fact that a single circuit is used. A novel feature of the circuit is the absence of a grid condenser, the method of biasing by tapping the rheostat being used, as in one of the unbeatable navy tuners.

### A Microphonic Amplifier for Crystal Detector Sets

THERE has appeared in England a device which enables the user of a crystal detector set to amplify the signals so that the results obtained are more on a par with those from the usual vacuum tube detector and amplifier sets. Thus the crystal detector, which is highly efficient as far as it goes—but it doesn't go very far—may yet come into its own during the present radio telephone development.

The device is known as the Brown amplifying relay or microphonic relay. With it the ordinary crystal detector signals may be magnified from 20 to 30 times. By referring to the accompanying schematic presentation of the relay, it will be noted that the current from the crystal detector, which is normally brought to the telephone receivers, is in this case led to the winding *W* 1, which forms part of an electromagnet, the latter being made exceedingly more responsive to even weak fluctuations of detector current by means of the extra winding *W* 2. The *W* 1 winding is quite similar to that of the usual telephone receiver, while *W* 2 is a much heavier winding supplied with current from a local battery *B*. To pick up and amplify even the most minute currents a highly sensitive microphone *M*, is mounted as shown. It is delicately fixed on one end of the vibrating steel arm *R*, whose amplitude of vibration can be carefully and accurately controlled by means of a set-screw. The microphone circuit consists of a battery, a step-up transformer with primary and secondary windings, *S* and *P*, a condenser *C*, and a pair of low resistance telephone receivers *P*.

The current to be amplified enters the coil *W* 1, and this current affects the vibrating reed *R* just as the diaphragm of a telephone receiver is affected. As the vibrating reed *R* is intimately connected with the microphone, any variation which it undergoes will be faithfully transmitted to the microphone. This action of the microphone, which is highly sensitive, modifies the current flowing through the circuit with corresponding change in the flux density of the telephone receiver. The vibrations of the reed *R* are affected by the pull of the magnet, the flux of which is increased by the flow of the current through the windings *W* 2. Thus, the fluctuating current from the microphone is repeated back and remagnified. These strengthened impulses are passed through a step-up transformer, and the amplified signals are reproduced in the low resistance telephones. An amplification, practically equivalent to a single step of audio frequency with a vacuum tube, is thus obtained.

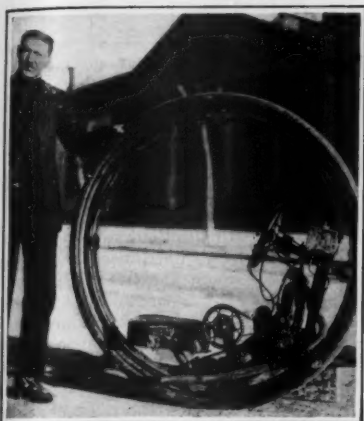
### German Water-less Gas Holders

WATER-LESS gas holders, representing a radical departure from present methods of storing gas used by American gas companies, are reported to be in use in Germany, according to the statements of a New York engineer, recently returned from Germany. The information is to the effect that there are 29 water-less gas holders, some as large as 1,000,000 cubic feet in capacity, operating successfully in Germany. This holder is built on the same principle as a vertical steam cylinder with the piston moving up and down in it. The contact of the movable crown with the side wall is made gas tight by means of a tar seal. Owing to the relatively high value of building space in German cities these holders are taller than ordinary holders.



# Inventions New and Interesting

*A Department Devoted to Pioneer Work in the Various Arts and to Patent News*



The unicycle that works by running up the side of the big wheel

## Again the Unicycle

THE unicycle is not a particularly new idea, but the version which we illustrate herewith has some decided features of novelty. Instead of employing a trick suspension of some sort to preserve the rider's upright position, the present inventor, an Italian policeman, O. P. S. Urbano, puts his engine and seat on the inner circumference of the big wheel, without anything that could properly be called a mounting at all. These members, together with the steering gear, are bound together by circular side-bars into a single unit; and this unit simply tracks in the flanges on the inner side of the wheel, in such a way that it can run around inside the big wheel but can never fall off the latter.

The running principle is then extremely simple. The engine is started and thrown into gear, and the inner unit, with the driver in his seat, starts to run up the inside of the big traction wheel. Before it gets far enough up to cause it to slip backward, the center of gravity of the whole ensemble has been thrown sufficiently far forward to start the big wheel rolling in the effort to bring the inner assembly to the bottom again. But the inner assembly keeps right on climbing, and the big wheel therefore keeps right on rolling.

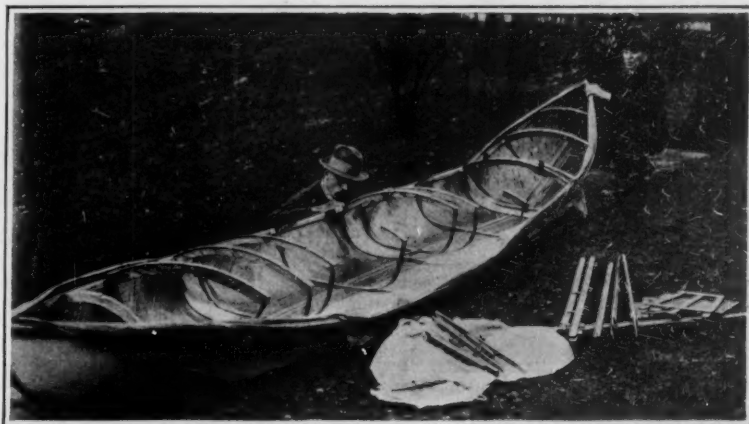
A ground speed of between 30 and 50 miles per hour is claimed for the novel vehicle. Steering is effected by throwing the weight of the inner unit off to one side, tilting the whole vehicle in the effort to maintain equilibrium and, as a secondary result, diverting its course to one side. We judge that considerable

practice would be necessary to acquire the skill for driving this unicycle safely at speed; but given such skill, it must afford quite a thrill.

## Boat That Packs in Small Compass

COLLAPSIBLE boats have been offered before, and will doubtless continue to occupy the inventor's mind. An unusually well-thought-out design is the one herewith shown, which comes to us from Germany, without any clear indication of its precise point of origin. The hull is divided into three sections; and each of these is split longitudinally along the keel. The result is that the six pieces of the hull can be nested quite compactly and without material loss of space; and in the space that is left may be packed the cross braces which are being put into place in our picture, showing the assembling of the craft. When properly taken down and packed, this little vessel can be carried in what amounts merely to an exceptionally large suit-case; and its putting together is an extremely simple matter.

Collapsible boats are quite popular with European inventors, and no end of photographs are sent to this country showing all manner of collapsible boats. The type here shown is quite common. Another type has collapsible pontoons which are inflated with an air pump. Another comes in sections.



The newest collapsible boat from Germany, where collapsible and portable boats are quite popular with inventors and public

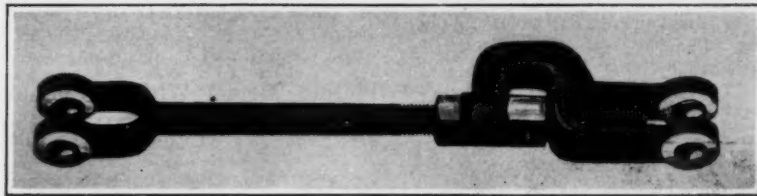
## Easier Brake-Rod Adjustment

ONE of the things that every automobilist knows has to do with the difficulty of taking up a brake rod. The business of taking the whole yoke apart and putting it together again two or three times until just the right degree of tension has been attained is one of the things that is provoking beyond all proportion with its actual difficulties. But with the new style of adjustable

gine it is customary to localize, at least to some extent, preferably in the vicinity of the spark plug, that portion of the charge containing the fuel and to admit through another valve sufficient air to fill the remainder of the cylinder, thus preventing the formation of a mixture too lean to burn.

## The Connecting-Rod Machine

THE automobile industry affords one of the widest fields for the design of special tools and machines; and while most of these are of such sort as to belong rather in the factory or the assembly plant than in the repair shop, the latter, too, is not without its appeal to inventive ingenuity. We illustrate herewith a very clever precision machine especially adapted to the testing and straightening of connecting rods, with or without their pistons; and the pouring and boring of connecting-rod bearings. Our photograph shows the machine set up and with work ready for the operation of boring a connecting-rod bearing. It is to be understood that this bearing has already been poured with the aid of the machine; and in this connection we must give attention to the claim that a bearing poured and anchored in the connecting rod is far superior to half-bearings simply laid in. One specially formed cutter, furnished in four sizes, is used for the entire work of boring, facing and filleting. A very ingenious piston indicator comes with the machine for testing the alignment



The yoke-end that takes the guess out of brake-rod adjustment

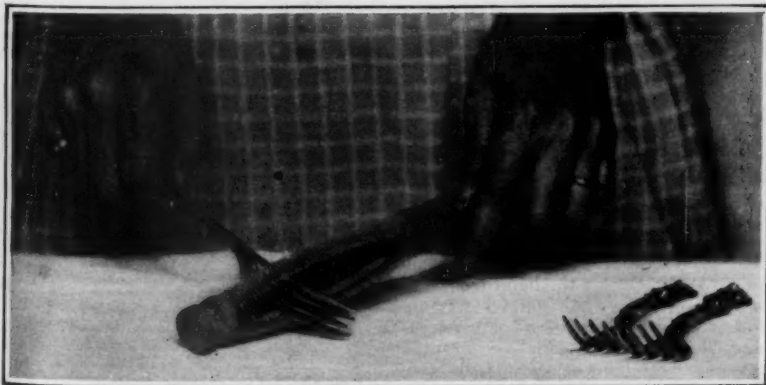
## To Clean the Fork

GETTING between the tines of a fork and removing all the foreign matter is by no means an easy task, when attacked in the conventional manner with no other aid than dishrag and washing powder. Accordingly, a New York department store is offering a little arrangement of brushes that runs a very searching bristle right down to rock bottom in the space between the tines. In reality it is four small brushes mounted together; and as the fork is pushed through, and sawed back and forth between these brushes, it is thoroughly cleansed.

yoke recently put out from Green Bay, Wis., and adopted as standard equipment by several car manufacturers, this will all be a thing of the past. As our picture shows, the yoke has a semicircular bow just above the fork; and the adjusting nuts are placed, one in this bow and one above it, while the rod runs clear through the bow and out into the fork. The rod and the means of adjustment are thus entirely independent of the eyes, etc., by which the yoke is anchored to its moorings; and adjustment is no longer a matter of trial and error. The two adjusting nuts are turned up a little at a time, and at any stage trial of the tension may be made without putting anything temporarily together, since nothing has been taken apart.

## Constant Compression Engines Economical

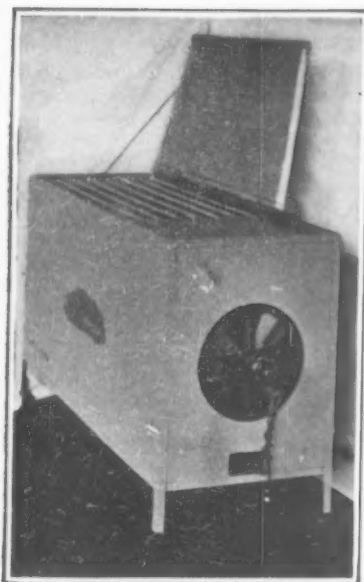
ONE of the chief disadvantages of the conventional throttling four-stroke engine is the fact that its economy falls off rapidly as it is throttled for part-load operation. At light loads the fuel consumption per brake-horsepower is sometimes three or four times that at full load, yet the average passenger car engine operates most of the time at less than one-third load. Various attempts have been made from time to time to overcome this disadvantage by the use of some constant compression type; that is, an engine in which the compression pressure remains constant regardless of the load. In such an en-



Brush assembly that insures a thorough job of cleaning between the tines of a fork



Ready to bore a connecting-rod bearing on the machine in which it has just been poured



Indoor clothes-drier for rainy days

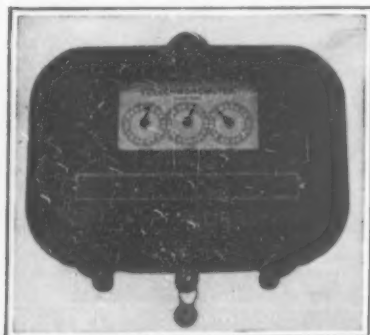
of the rods with pistons attached; and in the absence of the piston, the same test can be made by substituting parallel blocks for the wrist pin to bear against.

### The Telephone Meter

EVERETT, WASH., is the first town to have a telephone meter which, for purposes of billing and equally for the compilation of statistics, registers the duration of all calls made from the instrument to which it is attached. The electrical and mechanical design and construction of the "telechronometer" are simple. The central exchange is provided with a time-controlled noiseless pole-changer through which the battery supply to the calling end is carried, with the result that only the calling subscriber's meter will be actuated. The metering instrument is, externally, not unlike a three-dial gas-meter, save that it records in minutes, up to 9099. This gives it a capacity for about one week of continuous 'phone conversation.

After extensive tests the telechronometer was placed in general service in Everett in December, 1921. It was found after one month's study of the meter records that the smallest user coming under the "business" classification used the telephone for only 20 minutes in the month, the largest for 5720 minutes. Among the residence 'phones, the busiest was in use for 2740 minutes and the idlest for 10 minutes only. These figures, it is to be emphasized, are for outgoing service only, and include no count of the duration or number of incoming calls.

Analysis of these figures showed that the 10 per cent at the top of the scale got 'phone service at a cost of three-hundredths of a cent per minute, while 10 per cent at the bottom of the list, who used their instruments least, got service at a cost of five cents per minute.



The meter that times all telephone calls, and adjusts charges accordingly

While agreeing that every user should pay a minimum charge for the presence of the apparatus in his home or office, it was felt that the rates might advantageously be revised so as to make the heaviest users pay a greater share; and this has been done.

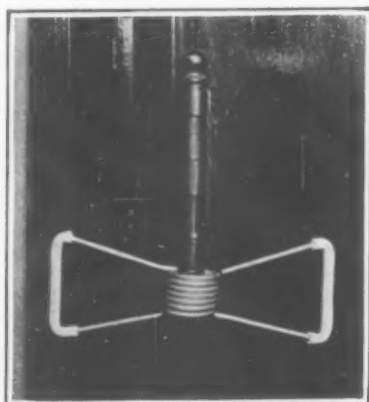
A feature of the telechronometer is its large elimination of the frivolous and unnecessary use of the telephone. It appears from results to date that, with a ticking meter right before the eyes of the person calling, something like 50 per cent of the duration of residence calls will be eliminated, making room for other subscribers on the same plant equipment and ultimately suggesting a further rate reduction. Further, the character of party-line service is greatly improved through the fact that if your neighbor wishes to listen in on your calls he does so only by taking off his receiver in the absence of a call to him from the central office. This automatically makes him a "calling party" as far as the meter is concerned.

### The Rainy-Day Drier

DRY days for drying laundry are assured with the use of this new electric drier. After the laundered articles are enclosed in this sanitary affair, connection is made with the electric lighting circuit and the fan in the side of the big box starts its work. The same apparatus is available for drying fruit, and as a deodorizer it also has value. In the latter use a bag of disinfectant is hung behind the fan, which of course in normal operation blows air out of the box, rather than in.

### Shut That Door!

THIS command will soon be out of date, if a recent inventor has his way. His device slips over the hinge of any door, and prevents it from standing open; and at the same time it can be slipped off the hinge and under the door to serve as a door stop and hold it in any desired open or partly open position.



Set on the hinge, this device holds the door closed

In connection with this double duty, it is necessary to point out that no screws are required for attaching the little spring-and-wing outfit. To attach, the wings are simply bent toward one another and the spring slipped over the hinge. Removal is just as quick and easy as attachment.

### The One-Piece Rotor

ONE not versed in the art of the electrician might be pardoned for supposing that the accompanying picture represents a new type of handy door-mat, or a collapsible wash-board. The fact is, it is the indestructible rotor of a new type of electric motor. Every motor user is familiar with motor trouble caused by loose rotor bars. This arises because, in the ordinary motor, each bar is joined separately to the end

rings, and among the multiplicity of joints thus afforded, some are always likely to come loose. In the rotor illustrated, the entire winding consists of an integral sheet of copper, punched and formed by a special mechanical process. This one-piece winding is machine-wrapped around the rotor core, the copper bars being expanded into the core slots by swaging. The single joint which extends through the two end rings is silver-welded, after which the metal at both connections is processed by means of a contracting operation that rehardens the copper at the point where the welding heat had softened it. This treatment results in a lapped, silver-welded joint of maximum strength. The rotor winding, except for the joint in



The quick-and-easy fire extinguisher

the two end rings, is electrically and mechanically just as substantial as a piece of copper pipe. The rotor core is a self-contained unit, and having a straight key may be pressed on and off the shaft. The motors of the new type are made in the standard industrial sizes, voltages and frequencies.

### Plating Metals With Chromium

A NEW departure in electro-plating, which is likely to be of wide importance, is announced as emanating from Sheffield, England. It is a new method of electro-plating by depositing chromium on iron, steel, copper, nickel and brass by electro-deposition. If the claims are substantiated the innovation is likely to modify profoundly conditions in the cutlery, electro-plating and other industries. Chromium is the metal which, when added to certain steels, produces the now famous stainless steels. It is harder and more durable than any of the metals now used as coatings to prevent rust, such as nickel, silver, etc. It also resists oxidation by air, water and acids. The new method is recommended for plating spoons and forks, hollow-ware, knife blades and many other articles, ornamental and otherwise. It is possible that this new chromium plating process may be used for rendering ordinary steel knife blades stainless. Although the metal is more expensive than other plating materials, this is not considered a serious objection.

### Taking the Fatigue Out of Screwdriving

RATCHET screwdrivers in the nature of the case live partly up to this ambitious heading; but few of them live wholly up to it. The trick about the one illustrated lies in the knurled ferrule. Easy running screws may be turned without taking the hand from the handle at all—the finger on the ferrule or off of it makes the difference between engagement of the blade or of the ratchet. Two blades come with the handle, and are interchangeable without adjustment; and one reamer blade is supplied as well.



The one piece rotor that gets away from much motor trouble

### Handy for Fires

WHAT we illustrate here is not a toy, pocket edition extinguisher, but one of real value for home, shop and motor car. Being sealed it requires no periodical inspection, but remains active indefinitely, until used. A wire frame passes about the base and is secured in place by a single screw. This makes it an easy matter to move the extinguisher from place to place, and always to have it at hand. The liquid used is the customary carbon tetrachloride of the larger extinguishers. To use this extinguisher it is only necessary to tear it from its wire mounting and throw it at the fire.

### Frequent Washing Spoils Body Finish

IT is a fact that cars that are washed only at intervals retain their body finish for two and three years, while those that are subjected to the nightly attack by garage attendants appear faded and dull at the end of their first season. For the average car a daily washing is as unnecessary and as harmful as a daily scrubbing of your hat. In reality the well-finished car body goes through as many operations in the paint and varnish shops as an expensive grand piano and in judicious and improperly conducted cleaning and polishing operations work as much harm on the one as on the other. In most cases wiping the surfaces with a flannel cloth to remove dust will restore their luster without injuring the delicate finish. When the car is washed it should be done with as little neutral soap as will remove the grease after which everything should be rinsed and then carefully wiped dry with clean chamois. A good grade of body polish can then be applied sparingly and the varnished work well rubbed.



An improved ratchet screw-driver





Stringing beans by machine and cutting them at the same time into three pieces

### Stringing the String Bean

THOSE of us who buy Mr. Burbank's stringless bean will not need this kitchen device. For the rest of us, it will string the string bean, operating merely with a turn of the handle. In addition, with one operation it cuts the bean into three pieces ready for serving when cooked. The handy little device is provided with a clamp so that it can be fastened to any kitchen table.

### The Two-Headed Tooth-Brush

TOOTH decay starts at the surface of the teeth. Not on the front surface alone, as most of the tooth-brushing done might seem to imply, but equally on front and back surfaces. To eliminate the decay, the brushing must clean the surface—on both sides. The brush illustrated has more than one advantage in this connection. The ordinary part of it is constructed with the tufts sufficiently spaced so that the pointed tufts can readily enter the interstices between the teeth. In the bargain it is recognized that no amount of contortion is going to enable one to brush the back of the teeth properly with such a brush, of the normal shape. So at the other end of the handle, on a little crook, is placed a smaller tuft of such size and shape as obviously to be available for the part of the job in question. With this double-headed brush there is no reason why every part of the teeth cannot be adequately cleansed.

### Heating an Eight-Story Building by Friction

A HEATING system which will use heat generated by friction in the flour grinding process is being installed in a new mill now under construction in Kansas City, Mo. The new heating sys-



The ingenious tool that makes it easy to spread rims or to collapse them

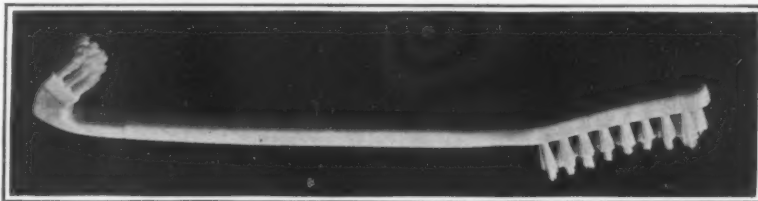
tem was developed during the experiments in using exhaust heat to regulate the humidity of the air in the new mill.

Engineers estimate that enough heat is generated in the milling processes to steam a boiler of 150 horsepower and that the new system will result in a saving of at least 300 tons of coal a year.

It is said that it is the first time that heating a large building by friction has ever been attempted. Heat generated by the grinding process in the milling machines and from the friction in the transmission machinery is discharged from the exhaust pipes into a dust remover on the top floor of the eight-story building. A large fan in the basement then draws the heat through an airshaft to the basement and forces it up another airshaft to the top floor, thus making a complete airshaft circuit from the basement to the top floor.

The hot-air circuit established, the rest of the heating plan operates in a manner practically the same as the hot-air furnace heating system. The hot air moving up in the circuit is discharged from the airshaft into any of the floors through a hot air opening. Another opening on each floor allows the air to empty back into an airshaft on the opposite side of the circuit.

When the milling machinery is not in operation the building will be heated by furnaces, which are installed in the basement as a part of the new system. The plan will operate in the same manner when the furnaces are in use, the air being pumped over the heated furnace and into the same airshaft circuit.



The brush that will reach the back of the teeth

### A Rim Tool That Is Never in Its Own Way

HAVE you ever tried to replace a rim in its tire, with no better tool than a screwdriver or something else that would merely play the rôle of an ordinary lever? If so, you have had an experience that is not easily forgotten. Time after time you have pried the free end of the rim down past the tight end, only to find that you could not withdraw your lever without having the free end of the rim fly out with it. Finally, more through luck than judgment, you have succeeded in performing the trick; and you have expressed a pious hope that you will never have another puncture out of reach of a garage.

The tool which we illustrate gets away from all this. It grips the free end of the rim from the side, and the anchored end in the same way. Accordingly at the critical moment when the free end goes down past the tight end, the lever is entirely out of the way and cannot possibly interfere with the operation. The tool is equally available for collapsing and expanding the rim, and should be in the kit of every automobilist whose rims work like those of our picture. The grip on the sides of the rim cannot slip, since it is the result of turning down a wing-bolt until the tool clamps tightly on the rim.

### The Safety Gas-Tank Cap

IT is no uncommon occurrence, when motoring, to discover at some filling station that the cap for the gas tank is missing. This sometimes means more than a mere missing cap. Frequently dust and dirt go through the gasoline

line, causing trouble by cutting off the supply of gasoline.

The safety cap which we illustrate is not removed from the tank in filling. By a spring arrangement it can be raised to permit the hose to deliver gas. When the hose is removed it flies back into its permanent position. The cap also largely eliminates the probabilities of explosion if the car should take fire. It will automatically raise, under excessive pressure, to permit expanding vapor to escape. Moreover, in case some of the gas should become ignited under a filling operation, by snapping down the cap the fire will be brought under control.

While the utilitarian feature is the main requisite with this safety cap, it adds an attractive touch to the rear tank.

### New Light on the Origin of Coal

THE question as to how coal was originally formed has often been discussed and yet no entirely satisfactory answer has been given. It has generally been supposed that it is a product of the decomposition of the cellulose of dead plants. The cellulose consists of carbon, hydrogen and oxygen. Hydrogen and oxygen form new combinations, according to this theory, the carbon remaining behind in the form of coal. This hypothesis has been recently contradicted, however, according to a writer in *Reclam's Universum*, who states that Dr. Franz Fischer and Dr. Schrader, after extensive and long continued experiments, have formed a new theory. They point out that the first step in the



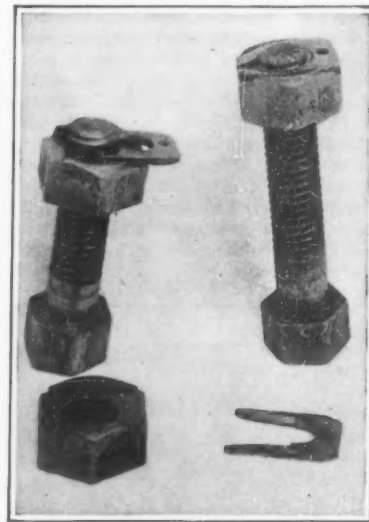
Safety for the gasoline tank

room has been constructed in which it is possible to exhaust the air during the operation to a pressure so low that it is greatly rarefied. This room is located in the interior of the building and is windowless. The floor, the walls, and the ceiling are made as air tight as possible. An exhaust pump in constant operation lowers the pressure to the desired degree. One side of the room abuts upon a small operation chamber and is connected with the latter by an opening placed at the height of the operation table.

The head of the patient lies outside the rarified air chamber and is under the observation of the physician in charge of the narcosis, while the rest of the invalid's body lies within the chamber in which, of course, the operating surgeon must also remain. The extension is provided with windows so that the operator can see the face of the patient. The two physicians can speak to each other by means of boxes provided with balloon cloth membranes. A telephone is also available. The passage of instruments from the smaller room into the rarification chamber is accomplished by means of intermediate spaces within which the air pressure can be equalized.—*Naturwissenschaften*, Berlin, Germany.

### The Latest Lock Nut

THE lock-washer and the cotter pin as used with the castle nut have somewhat halted the inundation of lock-nut inventions that used to swamp the patent office; but they have not dried up the source of inspiration entirely, as the accompanying picture shows. The nut in this combination has a slotted head, with the sides rising higher than the central part adjacent to the hole. When



The parts of a simple lock nut, and the way the thing assembles

### A Low Pressure Operating Room for Surgeons

A REMARKABLE new operating room has just been constructed for the use of the distinguished Munich surgeon, Dr. Sauerbruch, when performing pulmonary operations. Operations upon the lungs, of course, make it necessary to make an opening in the thoracic cavity by the removal of one or more ribs. As a consequence the external air flows into the space surrounding the lung and compresses these because of the more rarefied air within them. In order to prevent this a low pressure



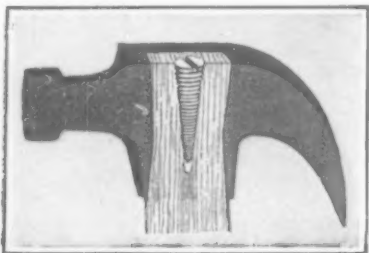
Leather armor for the sandblast operator

screwed upon the bolt, there is obviously a narrow slot on either side of the latter, between the threaded shank and the sides of this slot. Into these slots the double-ended pin is placed, and the ends bent together around the bolt—not altogether unlike cotter in procedure, but easier to do and far easier to undo when the nut is to come off. The shoulder of the pin digs into the thread—not enough to destroy the thread, but just enough to nick it and give the pin a firm seat.

#### Screen That Works Like a Window Shade

A DETROIT manufacturer has recently developed an interesting type of combination window screen and ventilator which does away with the annoyance of putting up screens as well as doing away with the removal for storing and painting. It simply operates as a window shade.

The new screen is made of a flexible roller screen which is made from a water-proof durable fiber-cloth, locked at every mesh by a patented process. It is claimed that this fiber-cloth will outwear many times the ordinary wire screen. When the window is closed the screen is in its metal case and as the window is opened the screen follows it up so as to cover the space left open. When the window is closed because of a rain the screen is protected in its metal case. When windows are washed a slight lifting of the metal-bound top of the screen disengages it from the window sash and it rolls up instantly out of the way. To engage the screen again the window is closed and the screen is picked up automatically.



The handle that grips the hammer head

#### On the Firing Line of the Sandblast

THE use of steel shot and grit as an abrasive for sandblasting is daily increasing. These metallic abrasives have two or three times the specific gravity of sand, and strike a harder blow in proportion, without disintegrating as is the case with sand. But the rebound of the abrasive projectile is correspondingly more wearing on the operator's hood and clothing. To meet the need for something to withstand this greater wear, the Hagerstown, Md., manufacturers of sandblasting equipment have placed on the market a shotproof hood and apron. The front of the apron is made of chrome leather, and protects fully the operator's clothing. It is held to his legs securely by spring clips, without binding the legs and without interfering with the easy putting on and off of the apron. The hood also has a chrome leather front and crown that resists wear as no other fabric can. A finely woven wire extra-heavy sight-screen that can be easily and cheaply replaced protects the operator's eyes and gives clear vision. The hood is made with an adjustable head-band to fit any size of head.

#### Motor Cars Help All Occupations

EVERY business, every profession, gains through use of the automobile, according to the answers received by the National Automobile Chamber of Commerce to thousands of questionnaires sent to car owners throughout the country. Farmers show a gain of 68 per cent in their individual efficiency. This is an especially important figure, as the farmer is the largest class of car owners. Farmer-owned cars total over 2,500,000 or nearly one-third of all cars in use. Bankers in rural districts find their cars productive in passing on mortgages and in getting acquainted with their out-of-town trade. The heavy gain here partially offsets the relatively



A screen that rolls up and down with minimum of attention

small car utility in these occupations in the large cities where the business is more confined to the office. Manufacturers report a great saving in their time through car use as plants are frequently several miles from their homes, and motoring proves the most efficient means of transportation.

#### A Firmer Hammer-Head

NEXT time the hammer-head comes loose or drops off, perhaps it would be worth while trying one of the handles which we illustrate—they are vastly superior to the home-made wedge. A tight fit to begin with, the handle is made secure against any ordinary hazard of use by screwing a big screw down into it. This screw tapers uniformly, like a wedge, and acts in every way just as does a wedge—except that the screw threads make it almost impossible for it to get squeezed out of its bed.

#### Sand Cutting Machine Propelled Like a Pushcart

THERE was a time when the cutting of sand for the molders in a foundry was done by hand. Today all this is changed and an electric machine is backed to the rear of the sand heap, the cutting cylinder raised and lowered into the sand, a switch turned and machine and electric energy do the rest. Power is employed only for rotating the cutting cylinders. The sand-cutting machine is propelled like a push cart, with the man behind and the machine in front.

For a time after mechanical means was resorted to for the preparation of sand, large machines only were manufactured which gave an undue advantage to the large foundry over the small one. This machine weighs less than 700



The latest improvement in foundry machinery

pounds and can be used in small spaces, as its over-all width is but 55 inches.

In addition to cutting and mixing floor heaps of sand, it is well adapted to mixing batches of core and facing sand.

The arrangement of steering is so made that it can be guided without mechanism, and can make very short turns. The front wheels are of the caster type and mounted in inclined forks.

The cutting cylinder with its shield and the motor and transmission are carried in approximate balance upon a tilting frame having its fulcrum above and just forward of the center of the rear wheels. By tilting this frame backward the steel cutting cylinder is lowered into the sand and vice versa. This raising and lowering is done by a hand wheel at front end of the machine. A safety sleeve allows hoisting cylinder independently of the hand wheel.

Power is brought to motor by flexible cable which plugs into connections located at convenient locations. Cable can be of any necessary length and motor of any desired voltage, A. C. or D. C.

It is said that mechanically tempered sand has many advantages over other methods, being much quicker and cheaper cutting. Rapid cooling of sand, a full time for molding, as well as wet and dry spots eliminated are features that benefit foundry owners.

#### Threaded Catch Sockets

STURDILY built sockets that will easily support the weight of any reflector now manufactured and resist sidewise leverage and sharp blows, are now available. It is claimed for these sockets that the cap cannot pull loose from the shell and no amount of vibration will loosen the threaded ring when properly installed. The threaded ring, knurled to provide finger grip, securely holds the cap and the shell together. Two lugs in the cap fit in any pair of eight slots in the shell, effectually preventing any rotation between the cap and the shell.



A kitchen-sink strainer that does not drip

#### The Dripless Sink Strainer

ONE of the sloppiest of the many sloppy jobs that the housewife is called upon to perform is that of emptying the sink strainer. The contents of this are always soft and mushy, and they are bound to dribble some of their juice en route from the sink to the garbage pail. But a Cleveland manufacturer has obviated this difficulty, and at the same time given us a cover for the unsightly sink strainer. The trick is that the cover is on a wide-swinging pivot, and can be swung around under the strainer, acting then as a drip tray while the latter is being escorted to the usual garbage pail.

#### Automatic Leveling by Means of a Simple Pendulum

CONSIDERABLE ingenuity is shown in the design of the leveling instrument which has just been patented by George G. Townsend of Frostburg, Md. The tube is connected with a pendulum, swinging in a slot in the staff and plainly visible in our photograph. In such a way that as soon as the instrument is set up the tube comes to a true horizontal, regardless of the position of the staff—provided only the latter have some approximation to vertical position. Under ordinary conditions sight is taken by peep hole and cross wires, but it may be taken through the peep hole and one of several notches provided for the purpose; and when the light is poor the latter method is preferred, and is operable under very poor illumination. Trunnions and side plates provide a delicate yet strong suspension for the pendulum, and this suspension is not impaired by variations in temperature.



An improvement in levelling instruments



# The Service of the Chemist

*A Department Devoted to Progress and Achievement in the Field of Applied Chemistry*

Conducted by ISMAR GINSBERG, Chemical Engineer

## Building Material From Corn Cobs

IT is estimated that there are about 20,000,000 tons of corn cobs produced annually in America. Up to very recently this material has been entirely wasted, but recent experiments have shown that there are many useful purposes to which these waste products can be put. The latest use is in the manufacture of a lumber substitute. (See United States Patent No. 1,427,378.) The product cannot bear up against great tensile stress but it can be cut and machined just like wood.

The process consists in grinding up the corn cobs, sprinkling the ground material with water until saturated, and then cooking in a closed vessel at a temperature ranging between 120 and 160 degrees Centigrade for from 30 minutes to two hours. The resulting mass is then pressed to remove the liquor. The colloidal matter present in the corn cobs is dissolved out in this way and after the water has been evaporated, a useful adhesive is obtained. The fibrous material, obtained above, is then mixed with a suitable binder and pressed into forms in molds or rolled into sheets.

## Coal Dust As an Engine Fuel

THE quest for petroleum and for petroleum substitutes goes on unabated in France. Recently attention was called to the high degree of inflammability of coal dust in various degrees of sub-division and concentration. Experiments were undertaken and these proved that coal dust will remain suspended in air almost indefinitely. Furthermore when the coal is rich in volatile matter, a very explosive mixture is formed with air. The possibility of using such an explosive mixture in internal combustion engines has been investigated. The admixture of coal dust, colloidal coal, with certain vegetable oils of high specific gravity, is claimed to give a fuel which can be used to advantage as an engine fuel. The coal dust is derived from French lignites and the oils from French West Africa. About 150 grams of powdered lignite will yield on combustion in one cubic meter of air 825 calories, as much as 75 grams of gasoline.—*Jour. Soc. Chem. Ind.*, 1922, 481R.

## New High Pressure Steam Turbine

A NEW high pressure steam turbine is being erected in Berlin, according to the *Industrie und Handels-Zeitung*, October 1, 1922, which will work under a steam pressure of 1600 pounds per square inch. The pressure of the exhaust steam is about 190 pounds per square inch, and this steam is then used in a low pressure turbine. A Swedish invention is used in overcoming the technical difficulties prevailing in the generation of such high pressure steam.

## Refining of Naphthenic Acids

NAPHTHENIC acid possesses a very strong, penetrating odor, which has been of distinct disadvantage in the application of the substance for certain purposes. It is now reported that a process has been perfected which removes the odor of the acid entirely, so that when some of the substance is impregnated into textile fabrics or smeared over the skin, no odor is noticeable after

the acid has been removed. Furthermore, attempts to make light-colored artificial resins from the acid have proven successful. A light resin can be made from the substance, which resembles resin closely, and which is better than resin as far as hardness, elasticity and solubility are concerned. Artificial waxes and varnishes can be prepared from these resins. It also appears that the naphthenic acid, its water-soluble salts and its esters all possess antiseptic and other important physiological properties.—*Chemische Umschau*, 1922, 357.

## A New Galvanic Element

A NEW galvanic cell is described in *Kraft und Stoffe*, October 8, 1922. This cell consists of a glass vessel, which is filled with a neutral electrolyte, such as sal ammoniac solution and which contains two electrodes. One electrode is made of sheet zinc and the other is formed of a bundle of tubes, arranged parallel to each other and perpendicular to the vessel. These tubes contain a coating of spongy silver. The electrolyte rises in the tubes due to capillary action. Inasmuch as the free air has access to the tubes, the hydrogen gas, which is set free from the electrolyte, combines with the oxygen in the air. In this reaction the silver plays a partial role as a catalyzer. The one undesirable action is formation of oxychlor acid, difficult to dissolve, in combination with zinc and ammonia in new elements. This results in the stopping up of the tubes. However, it is possible to prevent this from taking place, in a manner similar to that applied in the Leclanche elements, namely by adding zinc chloride to the electrolyte or by using a weak solution of chloride of ammonia, containing 80 to 100 grams to one liter, which itself is mixed with sea salt. The electromotive force of the new cell amounts to 1.07 volts.

## Dolomite Bricks

THE Ceramic Division of the Bureau of Mines has recently made some experiments at Columbus, Ohio, with bricks made from dolomite. Both raw and calcined dolomite, mixed with about 10 per cent of flux (iron oxide, alumina and silica), were used in the tests. The calcined dolomite was proved to be unsatisfactory, while the bricks made with the raw product gave very good results. The bricks were burned at a temperature of 1450 degrees Centigrade and possessed a high density. There was no sintering at this temperature.

## Benzol as a Motor Fuel

IN *Petroleum* the possibility of using benzol as a motor fuel is discussed and both advantages and disadvantages presented. Benzol evaporates more slowly than gasoline, freezes more readily, and while it shows a greater mileage per gallon, it gives less per pound with our present carburetor. Benzol gives rise to the formation of more carbon, but this carbon is easily removed, does not stick to the rings so readily, and does not cause preignition.

Benzol performs best at constant load and its thermal efficiency is the equal of gasoline, provided it is perfectly vaporized and mixed with air, of which it requires a greater percentage for combustion. Benzol is most efficient at low

speeds because of its low rate of flame propagation, but pure benzol cannot be used successfully. Alcohol and benzol form a much more effective mixture.

## Reducing Evaporation of Oil

ONE of the chief problems in oil storage is the loss due to evaporation. When oil is stored over a considerable length of time this loss really amounts to an appreciable waste. The oil companies have been working on the problem and it has been announced that a solution has been found in the preparation, known as "sealite." This is a composition of glycerine, glucose and glue. The mixture is poured into the tank through vent holes and soon covers the entire surface of the oil. It effectively prevents the evaporation of oil, and tests, which have been carried on for over a year, indicate a reduction of waste of nearly 75 per cent. The saving is quite considerable, and the initial cost small. Moreover, it appears that the life of the sealite is indefinite.—*Oil Weekly*.

## Fire Extinguisher From Waste Pulp Liquor

THE utilization of waste pulp liquor, that is recovered in paper mills operating the sulphite and soda processes to manufacture woodpulp, has always been more or less of a problem. The pulp liquor or glutrin, as it is also called, has but little commercial value. When these liquors are evaporated they become very viscous. Their use has been proposed as a fire extinguisher in fighting fires in oil tanks. Water is of little use for this purpose, as it tends to spread the fire. It has, however, been found that a foam, which will rest on the surfaces of the burning oil, is very effective in extinguishing the fire. Such a thick, heavy foam is formed by these evaporated pulp liquors. This foam is so heavy that the fire cannot break through and hence is smothered. The addition of a small amount of carbon tetrachloride tends to enhance the fire-extinguishing properties of the foam. For further details the reader is referred to United States Patent No. 1,428,207.

## Graphite Discovered in British East Africa

IT has been reported that large deposits of graphite have been found in the Kenya colony in British East Africa. The deposits are close to the surface. A factory is to be erected at Nairobi and graphite products will be manufactured there.

## Industrial Electro-Osmosis

THROUGH the action of the electric current in electrolyzing colloidal solutions, there are gained some very important effects which can be utilized to good advantage in various chemical industries. For example, the purification of clay, the manufacture of colloidal silica, the purification of tanning liquors and the tanning of skins, the sterilization and improvement of perishable products, such as meat, eggs and various food preparations, the conservation of green fodder, the purification of glues and gelatines, particularly the gelatines used for photographic purposes, the preparations of pure serums, the extraction of sugar from molasses and the decoloration of sugar juices, the purification of and elimination of alkaloids, the

electro-osmotic purification of crude glycerine, the manufacture of hydrate of alumina, the dehydration of coloring matters, the refinement of minerals, particularly graphite, the recovery of the soda contained in the residuary cellulose spent liquors are a few ways in which electro-osmotic action can be used to practical advantage in the different fields of chemical enterprise.

## Preservation of Glue and Gum Arabic Solutions

IN *Chemiker Zeitung*, 1922, page 922, there is described a new disinfectant, known as Parol. This product has a strong action against bacteria and also toward the formation of molds. When used in a 0.1 per cent solution, which is as strong a solution as is necessary, it is non-poisonous, almost odorless and has no irritating effect. It may be used in the place of mercury sublimate, carbolic acid, cresol, etc. About one gram of the substance is required for one liter of glue solution.

## Cement From Blast Furnace Slags

MANY attempts have been made in the effort to make cement from acid blast furnace slags by fusing them with lime. In Germany the increasing scarcity of building materials and the production of very large quantities of the slag have led the chemists to turn their attention once more to this problem. Two processes have been developed which have given very promising results. One of these, called the Wennerstrom method, consists in heating by electrical means the slag with lime in a graphite-lined circular furnace. The Gruen method, on the other hand, first converts the slag into a basic compound by the addition of alumina to the charge either before or simultaneously with the lime. The alumina reduces the melting point of the mixture and enables it to take up more lime. The resulting product when finely ground with clinkers makes a good cement.—*Jour. Soc. Chem. Ind.*, 1922, 511R.

## Tannins from Sulfate Cellulose Liquor

IN the *Schweizer Chemiker Zeitung*, 1922, page 572, there is described a process of making tannin esters from waste sulfate cellulose liquors, recovered in paper mills. The waste liquors are treated with toluene sulfo-chloride, which is a by-product recovered in the manufacture of saccharin. The lignin sulfonic acid, which is contained in the sulfate cellulose liquors, possesses only a slight tanning effect. Through the influence of toluene sulfo-chloride in the form of an ester of toluene sulfonic acid, a solution of tannin is formed, "ester-tannin." When the acid percentage in this solution is correct, the solution possesses tanning properties which can be utilized to good advantage. The process is carried out by allowing the sulfo-chloride to act on an alkaline solution of the sulfate cellulose liquor. When this "ester-tannin" is used in the proper manner, it produces a good leather of somewhat lighter color than that which is obtained with the ordinary natural tannins. It is quite advantageous to use this synthetic tanning material in combination with the natural tannins.

# Short-Time Tests for Long-Time Endurance

## How the Testing of Metal for Fatigue Limits is Being Put Upon a Production Basis

By J. W. Harsch

**I**T IS a well established fact that steel when subjected to many repeated loadings will often break in fatigue, although the stresses developed may be well below the static strength.

Upon examination under the microscope, fatigue is revealed as a slippage through the crystals along their cleavage planes. The development of this slippage is progressive, forming first what are known as "slip bands" in the separate and weaker crystals, then across several crystals, the "slip bands" gradually widening until at the weakest point the fracture takes place. Such "slip bands," symptoms of advanced stages of fatigue, are shown in the photograph. Fatigue is not, however, the most appropriate name for such a failure, the term "progressive failure" being considered much better. It was believed, at one time, that fatigue was due to a general deterioration of cohesion among the several parts or a sort of crystallization, because of the crystalline appearance of the fracture but the use of the microscope dispelled this theory when it showed all metals to be crystalline.

The steel has been compared to the human body which is sure to suffer a breakdown when repeatedly over-exerted, although it may well stand the exertion for a short time. The comparison may now be carried further. As the physician quite often determines the abnormal condition of the body by the presence of a fever, so we can now determine the endurance limit of a steel in fatigue, by carefully noting its first sharp rise in temperature from the normal while it is repeatedly stressed.

The problem of fatigue of metals has long been of great importance to engineers interested in the design and use of high speed machinery. Fatigue testing is ordinarily a slow and tedious process requiring much time and attention to testing machines, so that engineers have been prone to neglect it. However, the advent of the airplane, the steam turbine and other high-speed machinery, with their very rigid requirements as to weight, has made fatigue testing not only a problem of interest, but a necessity.

This discussion deals very briefly with the results obtained by the Joint Investigation of the Fatigue of Metals, which has been in progress during the last two years at the University of Illinois and with a special short-time fatigue test which has been developed. For a fuller account, Bulletin No. 124 of the Engineering Experiment Station of the University should be consulted. In this investigation the rotating-beam type of testing machine was chosen for the basic series of reversed stress tests. The machine loads the specimen so as to give a uniform bending moment between the bearings. The top fibers of the specimen are in compression, and the bottom fibers are in tension, the stress in any given fiber being reversed from

**F**ATIGUE of metals is something with the bare existence of which most of us are acquainted. The idea that metals get tired just like men is in fact one that rather appeals to one's esthetic sense. The precise mechanism of metallic fatigue, however, is something of which we still have much to learn. Mr. Harsch, who was metallurgist to the Joint Investigation of the Fatigue of Metals conducted by the University of Illinois, the National Research Council, the Engineering Foundation and the General Electric Co., tells us here some of the most recent discoveries in this interesting field in as simple language as the subject permits.—THE EDITOR.

tension to compression once every revolution. This type of machine has been frequently used by investigators of fatigue, runs very smoothly, and permits an accurate determination of the stress applied.

In making tests on this machine, a stress which would cause failure in a short time was applied to the first specimen. In successive specimens the stress was reduced until a stress was reached at which the usual specimen could withstand 100,000,000 reversals without failure. Curves showing the relation of reversed unit stress to cycles for rupture were then plotted on double

between the endurance limit under repeated stress and the "elastic limit." The ultimate tensile strength seemed to be a better index of the endurance limit than the elastic limit. The Brinell hardness test furnished a fair index of the endurance limit somewhat better than the ultimate strength. Impact tests were not a reliable criterion of fatigue strength.

The determination of the endurance limit of a steel under repeated stress by actual repetitions of stress, requires so much time that it is not a practical commercial test, and so a reliable short-time stress has been a goal for many investigators of fatigue.

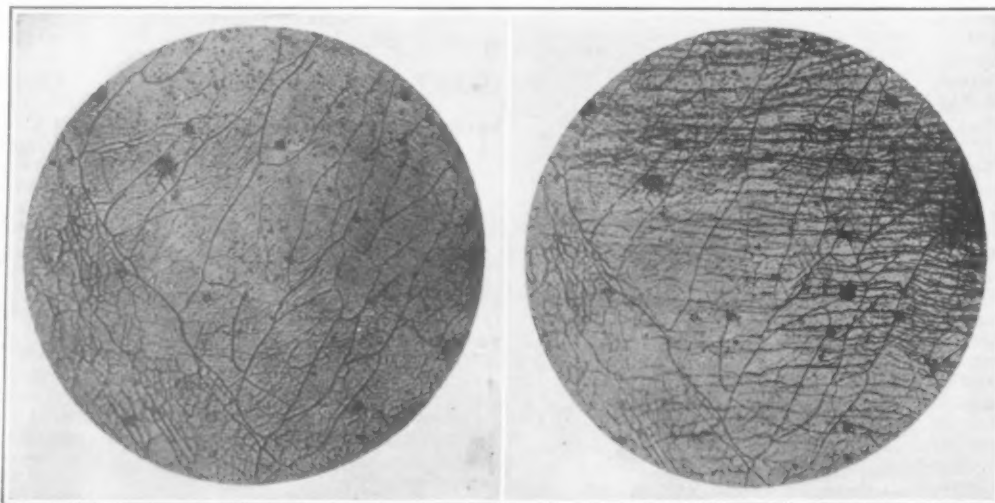
In 1914 Mr. C. E. Stro-meyer of Manchester, England, suggested the possibility of determining a "fatigue limit" by measuring the rise of temperature of the specimen due to in-elastic action. He was, however, unable to carry out a sufficient number of long time tests to establish thoroughly the temperature limit as identical with an endurance limit under repeated stress.

In the present investigation, a machine has been developed with which the endurance limit, under repeated stress, of each of the steels tested, could be predicted with a good degree of accuracy. The determination of the endurance limit in this machine is made by measuring with very sensi-

tive apparatus the rise of temperature under repeated stress and the complete determination can be made in about 30 minutes.

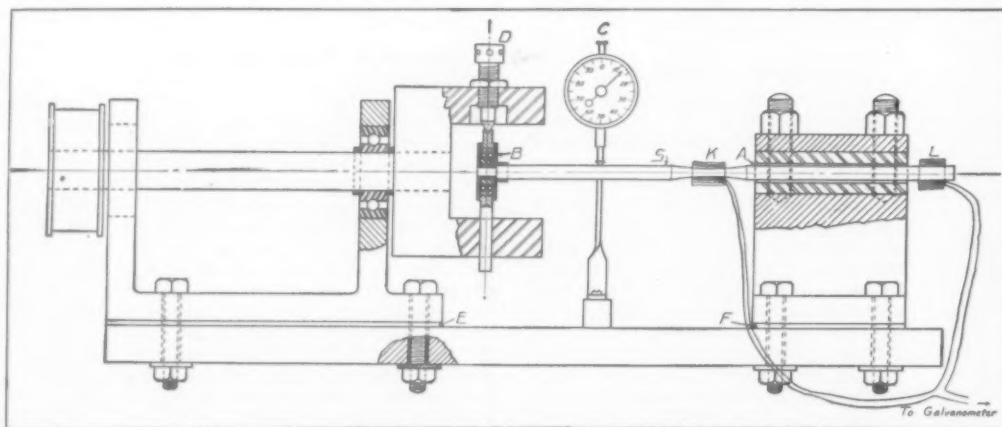
The apparatus used in making this test is shown in the drawing. The specimen *S* is held horizontally in V-notch grips *A*. The load is applied on a ball-bearing *B*, at the end of the specimen, the bearing being heat-insulated from the specimen by a fiber collar one-sixteenth of an inch thick. It was also found necessary to heat-insulate the machine at points *E* and *F* to prevent heat traveling from the bearings through the base to the specimen. The load on the specimen is measured by reading the deflection of the Ames dial *C*, a load-deflection curve for the specimen having been previously obtained by recording a set of loads and corresponding deflection readings. The load can be varied by an adjusting screw *D*, in the head of the machine. A thermocouple cannot be readily attached to a rotating specimen, and it will be noted that the machine is so designed that the specimen does not turn, but that the head of the machine rotates. The left-hand end of the specimen is thus moved in a circle concentric with

(Continued on page 288)



Photomicrographs of steel, showing the effect of repeated stressing above the endurance limit. Magnification, 100 diameters

logarithmic paper. These diagrams indicate that down to some value of unit stress, results of the tests may be well represented by a sloping straight line, and that at this critical point on the curve there is a decided break, and the curve becomes a horizontal or very nearly horizontal straight line. The tests have been extended to 100,000,000 cycles in all steel tested and such a critical point has been found as characteristic in every case. From test data it seems that for any value of stress lower than that represented by the break in the curve, the material would stand an indefinite number of re-



The machine with which the "endurance limit" of steels is tested



# The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGE, M. S. A. E.

*This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles*

## Progress in Motor-Coach Design

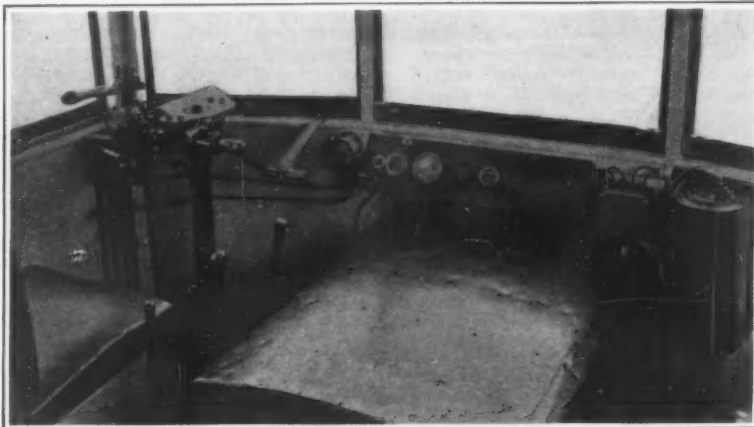
SINCE the days of the first automobile, various attempts have been made to design railroad equipment operated by gasoline engines. It seems rather remarkable that so little progress has been made when one considers the place that the gasoline engine has in the marine, aeronautic, stationary and in fact practically every power field except the railroad. The opinion prevails that there are definite reasons why progress has been slow up to the present time. The motor-coach will fill a decided need, but it must not be considered as a cure-all. It has limitations.

Great progress has been made in designing practical motor-coaches or railcars that will combine the good features of vehicles adapted for road transport with those designed entirely for use on rails. As these cars have so much in common with motor-trucks, as far as the basic principles of design are concerned, operators of road vehicles cannot fail to be interested in the rail-car proper.

On the other hand, builders of motor-trucks for several years have equipped chassis ranging from three-quarters to five tons capacity with flanged driving-wheels and with other means to adapt them to operation on rails. These cars, in general, have been successful. Due to light weight, low rolling resistance, the small engines required, and to the fact that in some installations they can be handled by one man, the operating cost has been exceedingly low. These cars, however, being unduly limited in capacity and speed, fill only a limited demand. There still remains a middle ground between the rail motor-bus or the rail motor-car, as we have known them in the past, and the proper field of the steam train. It is in this middle ground that the motor-coach can make a place for itself.

A motor-coach is defined as a passenger-carrying, gasoline-driven railroad motor-car, designed specifically for operation on rails. It is in no sense a converted motor-truck, but represents a combination of automotive and railroad practice. Previous attempts have been based almost entirely on one to the exclusion of the other. To illustrate, some of the earlier cars developed by the railroad men weighed more than 50 tons and required 300 horsepower, although seating capacity was provided for only some 50 to 60 passengers. They did not give due consideration to the automotive side of the design. Instead of building a gasoline car they attempted to use a gasoline engine in a car of steam-train design.

By careful design and the use of alloy steel, anti-friction bearings and other approved features of automotive practice, the weight can be reduced materially. The weight must be held to a minimum to keep the motor-coach requirements within the capacity of proved gasoline engines. It is also undesirable to forget the railroad point of view entirely. Many features of railroad design are the result of almost a century of development. The designer must weigh his problem carefully, choosing from railroad practice those features that fit this new type of equipment. The converted motor-truck does not, according to experienced railroad



Air brake at left of driver's seat, gear control at right; engine under sheet metal hood as in automobile practice

### Motor compartment of light-weight motor coach for railroad use

officials, meet the requirements. Due to the use of two-wheel driving trucks and other practices, it does not ride as steadily or as safely as the usual railroad car, which has a four-wheel truck under either end of the car.

There is an insistent demand for sev-

safety, steadiness, comfort and convenience of the steam-coach. We illustrate a motor-coach having an over-all length of about 44 feet, and a seating capacity of 38, in addition to drop seats for eight passengers in the baggage room, making a total seating capacity of 46. The bag-



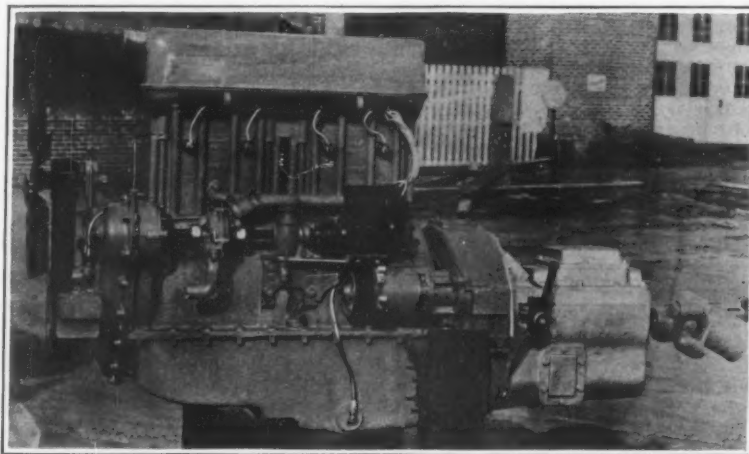
Note that drive is to all four wheels, through both axles, from special gear-box mounted in center of truck

### One of the four-wheel trucks on which the light coach is mounted

eral features not ordinarily included. Some of the more important of these are four-wheel pivoted trucks, front and rear; full speed in either direction; air-brakes and safety appliances. The motor-coach should combine the light weight of the motor-truck with the

gage space is 70 square feet. The car is provided with standard vestibule doors for entrance, a saloon, comfortable seats, electric lights and other features commonly associated with modern railroad design.

The total weight of this car is only



General view of the power plant of the light-weight rail coach

13 tons. This reduction of weight to less than one-third that of old-time motor-cars of the same capacity makes it possible to use a 68-horsepower engine, as against the 200-horsepower engine required by other types. At the same time a speed of 48 miles per hour has been attained and a speed of 35 miles can be maintained indefinitely without damage to the mechanism. Due to the light weight and the correspondingly small amount of power required, a car of this type will show exceptional economy. The fuel-consumption is light, the car running between five and seven miles per gallon of gasoline. Due also to the light weight, the car has very good acceleration, reaching a speed of 25 miles per hour in 30 seconds from a standing start. This car is arranged with two four-wheel pivoted trucks. The drive is from the unit power-plant, located forward, through an auxiliary transmission contained in the bolster of the front truck, to the two axles of the front truck. The auxiliary transmission is arranged so that either of two pairs of gears can be used for transmitting the drive, thus, in effect, giving two high-gears. One of these gears is proportioned for the ruling grade on the particular railroad on which the car is to be used, and the other is proportioned to give a maximum speed in straight-away operation.

Frequent service could be given where it is not justified now by a steam train. A freight-carrying unit might be installed in conjunction with a passenger unit at an initial cost much below that of a passenger unit. The gasoline motor-coach as a unit possesses many advantages over steam and electrified service; namely, speed, frequent service, low cost of operation, a crew of one or two men, the elimination of the usual terminal facilities and a great reduction in the initial cost. In conclusion, the railroad motor-coach is primarily designed for service where steam operation is too expensive and frequent service is desired.

There is a small branch line in the Blue Ridge Mountains that was getting only about \$30 per day in passenger revenue while the operating cost with steam train was \$46 per day. A 30-passenger gasoline motor-coach was installed and is running for about \$10 per day, or about 11 cents per mile; this is the total operating cost. Coal docks, water tanks, cinder pits, hostlers and the like are not necessary. That branch line, running from "nowhere to nowhere," is now making \$20 per day profit. This sort of operation is a live issue with the railroads. As a result of this showing this road has put on a second car, and it is doubling its service voluntarily because it pays. The larger cars will vary in operating cost, according to their capacity and speed. A car of this type can be operated from 20 to 30 cents per mile, depending upon the track, speed, number of stops and other conditions.

Because of the high cost of electrical equipment there is an opportunity for the practical gasoline car instead of the usual electric car. Where traffic is light the gasoline car can be installed at a low initial cost. Of course, the least expensive system is the bus line.

# The Heavens in April, 1923

## New Knowledge of the Nebulae and the Source of Their Luminosity

By Professor Henry Norris Russell, Ph.D.

**O**F THE rapid advances of astronomy in recent years, none has been more remarkable than the increase in our knowledge of the nebulae. A decade or two ago we knew little of these strange cloudy patches of light except their appearance in the telescope and on photographs, and something concerning their spectra. From the fact that they retained their positions unchanged among the stars for generations, we could conclude that they must be distant objects—at least as far off as the nearest stars, and probably much farther—and of enormous size, often far greater than the whole extent of our solar system. Some of them showed spectra composed of isolated bright lines, and in such cases we would be sure that luminous material was gas of low density—hydrogen and helium being readily recognizable, though the strongest lines of all could not be matched in our laboratories. The spectra of others appeared to be continuous; but with the relatively feeble instrumental power that had been applied to them, they revealed no indubitable details, and left us in great uncertainty as to the origin of the light.

Important differences in form were also revealed on our photographs. Some nebulae are small, roundish, and sharply defined at the edge, so that with a small telescope they look almost like planets—hence the name "planetary nebulae." All these show, by their spectra, that their light comes from luminous gas. Others, like the great nebula in Orion, show a diffuse and irregular structure—a fit model for an artist's conception of chaos; and the brightest of these, too, are definitely gaseous in spectrum. Still others, like the other great nebula in Andromeda, are of spiral form with a strong, but not sharp, nucleus and far-reaching outer whorls—and the spectra of these are continuous.

Nebula with the gaseous type of spectrum show a strong preference for the region of the Milky Way. All the spirals avoid it completely.

Though this evidence sufficed to show that the nebulae were not all alike, and must fall into several very distinct classes, it left us, at the beginning of this century, with very little idea of their real nature—even their distances and dimensions being uncertain, and much more the reason why they shone.

The first great advance came with the application of more powerful spectroscopes—and of the boundless patience required to make exposures lasting 10, 20 and even 40 hours, working every clear night and shutting up the apparatus light-tight between times. Meanwhile, evidence began to pile up of the existence of a third great class of nebulae, which did not shine at all, but revealed themselves only as dark clouds, hiding the more distant parts of the Milky Way behind them, and occasionally brightening up and becoming faintly visible, as if shining by reflected light—a hypothesis which was confirmed by the photography of the spectrum in some crucial cases. Among the many workers who brought these new facts to light the names stand out of Slipher of the Lowell Observatory, Wright and Curtis at the Lick, and Barnard at the Yerkes.

With this summary of the earlier work we may turn to the latest papers on this fascinating topic, coming from Hubble at Mount Wilson. These deal with nebulae of the galactic type—leaving the spirals and associated nebulae aside.

The diffuse or irregular nebulae—which are practically confined to the Milky Way, except for a few in the Magellanic Clouds—do not all show a gaseous spectrum. About half of them do; but the spectra of the rest are continuous, and (when they have been examined with suitable instruments) show dark lines, just as they should do if the nebula was not self-luminous, but was an opaque cloud, reflecting the light of neighboring stars.

In most cases the star from which the light comes

is easy to find. An isolated star, or a cluster like the Pleiades, is immersed in nebulosity, growing brighter near the star, in such a way that the connection can hardly be doubted; and the similarity of the spectra of such stars and of the surrounding nebulae (in the half dozen cases where the latter can be photographed without prohibitively long exposures) clinches the argument. Sometimes we have to look outside the visible nebula for the star which lights it up; but in such case there is usually a very bright star nearby, which suggests itself easily.

What is more remarkable, the nebulae which have bright-line spectra are also associated with stars—the evidence for the connection being of the same character, and equally strong; and there is a perfectly definite relation between the spectra of the nebulae and those of the associated stars. If the star is a very hot one indeed (of the spectral classes called Oe or BO at Harvard), the nebula shows a gaseous spectrum; if the star is cooler, the nebular spectrum is contin-

of distance and brightness show an agreement with theory which cannot be a matter of accident.

The final test is this: The nebular cloud, if as thick as a cloud in our own atmosphere, may reflect nearly all the light that falls upon it; but it cannot reflect more. Hence there should be a limit of distance, beyond which nebulosity cannot be set shining by any given star—namely, the distance at which a pure white cloud, illuminated by the star, would be just barely visible (on photographs made with the standard exposure to which the results have been reduced). Now when this distance is calculated it is found that in almost all cases the actual nebulosity stops short at this limit, or inside it. The two or three exceptions are reasonably explained by the suggestion that in these cases a nebulous cloud lies between us and the star, dimming its light and hence our estimate of its brightness.

This relation between the brightness of a star and the distance at which it can set the nebula shining holds true not only for those showing continuous spectra, but for the gaseous spectra too. Hence it seems practically certain that these nebulae, also, are set shining by something that comes from the stars. The influence in this case cannot be ordinary light; but it may be ultraviolet light of very short wavelength, or electrons emitted at high speed—either or both of which we might expect to find given off from the very hottest stars. One single nebula—a great oval in Cygnus, brightening up into two beautiful filamentous masses—remains outside the sequence, with no visible exciting star at all; but in this one instance out of nearly a hundred, there is good reason to accept Hubble's suggestion that the central star is there, but behind a cloud of dark nebulosity so opaque as to hide it from us completely, while letting its light escape in other directions.

### The Heavens

The winter constellations have almost gone, only Auriga, Gemini and Canis Minor remaining, low in the west. Leo and Virgo are high in the south, with the long stretch of Hydra below and the small groups of Crater and Corvus. Boötes is high in the east, with Corona, Hercules and Serpens below. Lyra is low in the northeast, with Cygnus rising. Cassiopeia and Cepheus are far down in the north, Draco and Ursa Minor above them, and Ursa Major almost overhead.

### The Planets

Mercury is in conjunction with the sun on the 8th, passing behind him, and is practically invisible except toward the end of the month, when he comes into increasing prominence as an evening star.

On the 30th he sets at 8:35 P. M. and is easily seen as a bright object, surpassing all the stars but Sirius, and situated a few degrees south of the Pleiades.

Venus is a morning star, rising about 4 A. M., and is still very bright, though now 100 million miles away.

Mars remains in the evening sky, setting at 9:40 P. M. on the 1st, and 9:20 on the 30th. Though fainter than Aldebaran, he is still a fairly conspicuous object.

Jupiter is in Libra, approaching opposition. He rises at 8:30 P. M. in the middle of the month, and is conspicuous in the late evening.

Saturn is in Virgo, and comes into opposition on the 7th, so that he is visible all night long. He appears to the eye as a yellowish star, about twice as bright as Spica (which is about 10 deg. to the southwestward), and in the telescope his rings are clearly visible, although still much foreshortened, and seem narrow.

Uranus is a morning star in Aquarius, rising about 4 A. M.; Neptune is in Cancer, setting about 2:30 A. M.

The moon is full at 8 A. M. on the 1st, in her last quarter at midnight on the 7th, new at 1 A. M. on the 16th, in her first quarter at midnight on the 23rd, and full again at 4 P. M. on the 30th. She is nearest the earth on the 1st and 30th, furthest away on the 15th.



At 11 o'clock: Apr. 7.  
At 10½ o'clock: Apr. 14.  
At 10 o'clock: Apr. 22.

At 9½ o'clock: April 30.

At 9 o'clock: May 7.  
At 8½ o'clock: May 15.  
At 8 o'clock: May 23.

The hours given are in Eastern Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on April 7, etc.

### NIGHT SKY: APRIL AND MAY

uous; if the star is just at the intermediate stage (Harvard spectrum B1), the spectrum of the nebula shows a mixture of both characteristics.

This suggests very strongly that it is the stars which set the nebulae shining, whether simply by the reflection of their own light, or by some other form of influence, which, emanating from the hottest stars alone, is capable of energizing the gases in the nebulae, and making them glow. But if this guess is right, there should be a definite relation between the brightness of the star and the distance at which it can excite the dark nebular material and set it shining. To produce the same effect at twice the distance, the star should be, not twice, but four times as bright—following the familiar law of squares. This rule applies equally, no matter whether we take the real brightness of the star, and the real distance, measured in light-years; or again the apparent brightness in the sky, and the apparent distance in degrees. The latter test is obviously the easier to make, and Hubble has applied it to more than 80 nebulae, with results which confirm the theory in a most striking fashion. Not only is it true in general that the brighter the star the further away can the nebulosity around it be seen, but the numerical values



# Recently Patented Inventions

Brief Descriptions of Newly Invented Mechanical and Electrical Devices, Tools, Farm Implements, Etc.

## Pertaining to Aeronautics

**AIRPLANE BLOCK FOR TAKE-OFF STANDS.**—J. W. BEASLEY, JR., 702½ S. Central Avenue, Los Angeles, Calif. The invention relates to a safety device for putting the blocks under the wheels of an airplane and releasing the same, whereby airplanes may be started in flight or tested while standing still without the necessity of persons holding the same while the propeller is in operation, in order to prevent advancement thereof, thus obviating danger to attendants.

## Pertaining to Apparel

**NETHER GARMENT.**—J. STEIN, c/o Climax Rubber Co., 520 Broadway, New York, N. Y. The invention relates to garment protectors for children, and has special reference to diaper covers. The primary objects are to provide a protector for shielding the upper clothes of the wearer, and in which means is also provided for the support of the diaper cover. A further object is to provide a garment which is durable, and simple in construction.

**NECKBAND.**—J. FEULNER, 18 Russell St., Middletown, Conn. The invention relates to wearing apparel, more particularly to a neckband for shirts. One of the objects is to so construct a neckband that the shape of the same is formed during the process of weaving the fabric from which the band is made. A further object is to provide a neckband in which the edge presented will be round, and the inner face soft, thus eliminating the possibility of fraying at the edge, with the consequent discomfort to the wearer. (See Fig. 1.)

## Chemical Processes

**INK COMPOSITION.**—J. W. BALSER, 217 Kentucky Ave., Westville, Ill. An object of the invention is to provide a writing fluid especially useful in writing bank checks and important documents, the fluid has particular penetrating qualities, so that it is not necessary to use a blotter, and the ink is so incorporated in the paper that it is not possible to erase it without mutilating the paper. The fluid includes, denatured alcohol, carbolic acid, water, sugar and a dye.

## Electrical Devices

**ELECTRIC REGULATOR.**—T. M. PUSEY, Kenneth Square, Pa. The invention has for its object the provision of a regulator designed to control the power furnished by the dynamo electric machine, whereby its regulation is effected in a very simple and efficient manner. A further object resides in the provision of means whereby the sensibility of the regulator throughout the entire range of variation in the voltage of the machines under control is made uniform.

**WIRING SYSTEM.**—J. W. HILL, 326 E. 7th St., Salt Lake City, Utah. This invention relates to a wiring system adapted for use in connection with the transmitting circuit of wireless telegraphy. The object is to provide a wiring system by which the electrical units may be wired in pairs, and then connecting the pairs so that each will be disposed at an equal distance from a common point in the circuit with which they are associated. (See Fig. 2.)

**BATTERY PLATE.**—J. N. HANNA, Ordway, Colo. An object of the invention is to provide a simple, strong and efficient frame,

constituting the support for the active material of the storage battery plate, which is so constructed as to provide freedom of movement for the various parts of the frame so that in expansion and contraction there will be no tendency for the frame to warp or buckle. A further object is to provide a direct course for the current to flow toward the head of the plate from any one of the sections.

**PORTABLE BURGLAR ALARM.**—F. CROSSMAN, Reno Hotel, San Francisco, Cal. The specific object of this invention is to provide an alarm comprising an electric ringing device that can be conveniently carried in a suit case or traveller's bag, can be quickly attached to any door knob and sounds the alarm when the door knob is turned in either direction. It is principally intended for travellers, and provides a convenient means of apprising them of any attempt to open the door.

**OUTLET BOX.**—J. BARRY, 458 Schenck Ave., Brooklyn, N. Y. An object of the invention is to provide means whereby an outlet box adapted to receive a plurality of cables can be fastened to any stud or joist and yet permit the reception of cables therein with a minimum amount of distortion. Another object resides in the provision of means whereby each cable is simply and efficiently clamped within the box without danger of tearing the insulation, which may result in short-circuiting the wires.

## Of Interest to Farmers

**SPRAYER.**—C. A. WOOD, c/o Wood & Fisher Implement Co., Rothsay, Minn. An object of the invention is to provide a sprayer having facilities for projecting selected powders and liquids upon the plants to be treated either selectively or simultaneously. A further object is to provide a sprayer having means for atomizing the liquid to be sprayed whereby the plants may be suitably moistened to occasion the adhesion of the powder subsequently cast thereupon. (See Fig. 3.)

**STUMP PULLER.**—C. B. GOLDSMITH, Gen'l Delivery, Oxnard, Cal. The invention has for its object to provide a device of the above mentioned character that concentrates an enormous power on the drum pulling the cable by means of which the stump is removed, is strong in its construction, can be made portable and is easily handled by one man.

**CONVERTIBLE FARMING IMPLEMENT.**—W. W. WHEELER, St. Johns Hotel, Columbia, S. C. The purpose of the invention is to provide a farming implement having interchangeable working elements to permit of its being converted with facility into a plow, cultivation or any other form of farm implement whereby a single implement can be used to perform the necessary operations in the planting, cultivating and gathering of crops.

**FURNACE.**—G. T. WYATT, Olmstead, Ky. Among the objects of this invention is to provide a portable furnace designed for use on ground used as a hot-bed or planted in tobacco-growing districts to thoroughly heat the ground and destroy weeds, and the like preparatory to sowing the tobacco seed, the furnace being simple and very durable in construction, and easily moved above the plot of ground.

**POWER-DRIVEN MOWING MACHINE.**—R. C. CHATTIN, Mountain Home, Idaho. The invention relates to a mowing machine in which the cutter blade is reciprocated by power means independently of

the movement of the ground wheels. An object is to provide a device in which the operation of the cutter blade may be controlled at will. A further object is to provide a device that is constructed to effect the balancing of the weight thereof on the axle of the ground wheels so that the stress of the draft animals is reduced to a minimum.

**AIR-CIRCULATING SYSTEM FOR ORCHARDS AND THE LIKE.**—L. M. ROWE, 1431½ Pleasant Ave., Los Angeles, Calif. The invention relates generally to the care of orchards and like places for preventing a drop in temperature from affecting fruits, vegetables and other plant life in the early spring, and has reference to a frost-preventing means which may be conveniently incorporated in an orchard for producing a circulation of air in such a manner as to remove the possibility of frost and thus save the fruit. (See Fig. 4.)

**GATE.**—R. HEARN, Dyer, Tenn. The object of the invention is to provide a gate for controlling a road or highway, as, for instance, on a farm, which will serve to prevent the passage of stock when the gate is closed. A further object is to provide a gate which may be operated from either side, the gate being adapted to be operated by a series of levers preferably arranged in the form of trap doors so that the gate may be swung open when a vehicle drives upon the same, and also having means for locking the gate in closed or open position unless manually released.

**BEEHIVE.**—W. J. PLATTEN, 218 N. Oakland Ave., Green Bay, Wis. An object of the invention is to provide a beehive which is constructed for out-of-door use in cold regions, so that a minimum loss of bees through freezing and starvation and a minimum consumption of honey is brought about. This is accomplished by constructing the walls of an insulating material with air spaces, and providing a small entrance for winter and a larger one for summer.

**POTATO DIGGER.**—J. W. SCOTT, Falcon, Col. The invention relates to a machine for digging potatoes which comprises a plow blade for unearthing the potatoes, a vibrating carrier for receiving the unearthed potatoes and for separating the potatoes from the earth, and means for adjusting the amplitude of vibration of the carrier in order to increase the working capacity of the machine.

**GRAIN CLEANER.**—R. H. OWEN, 412 W. Mercury St., Butte, Mont. The object of the invention is to provide a grain cleaner consisting in a receptacle or housing and so arranged that upon grain being delivered into the housing under air pressure, that the air pressure employed for delivering the grain may be utilized for subjecting the grain to a cleaning process.

## Of General Interest

**REFRIGERATOR.**—J. BECK, Ashland, Wis. The invention relates more particularly to the ice rack of a refrigerator and in association therewith a novel arrangement to carry off the drip and to provide for an effective circulation of the air about the rack and its associated features. The drip falling from the ice rack through the circulating air, results in the odors being absorbed by the water to be carried off through the drain pipe.

**KNEE REST.**—J. G. LAYCOCK, Address Miss Laurel McCormick, Russellville, Ohio. An important object of the invention is to provide a bed having a knee rest or limb

support which is operated simultaneously with the elevation of the back, and which may be operated by one person with a minimum of effort and inconvenience. Further the device is provided with means whereby the limb rest may be raised or lowered independently of the back.

**FASTENER FOR TAPE MEASURE AND OTHER ARTICLES.**—A. H. SELL, 858 13th St., Newark, N. J. The invention relates especially to an attachment for securing tape measures at one end so that one person may take measurements without the necessity of a second person holding the tape, but the device may be used for other purposes such as a fastening means for holding on end of a string or as a hanger or fastener for things to be secured to a wall or other surface.

**ENVELOPE.**—N. PEPIN, 172 Lincoln St., Woonsocket, R. I. The invention has for an object to provide an envelope which economizes material in the formation thereof and which operates to prevent the necessity of printing on the envelope as the letter contains a transparent sheet which exposes not only the address of the envelope on the letter, but also the return address of the sender.

**SIDE-DUMPING BOAT.**—F. P. EASTMAN, Produce Exchange Annex, New York, N. Y. The object of the invention is to provide a side dumping boat or scow which may be easily dumped and easily reset for a new load; the arrangement being such that the sides will swing outwardly and downwardly during the dumping operation so that there will be a quick release of the load on both sides in order that the equilibrium of the boat may be maintained.

**CAN TONGS.**—E. H. TAYLOR, Cliff Hotel, 204 East Jefferson St., Dallas, Texas. The purpose of this invention is the provision of a pair of tongs particularly designed, although not necessarily for the lifting of cans from ice-cream freezers. The invention is simple and inexpensive to manufacture, and so constructed as to readily penetrate the ice surrounding the can to effectively grip the can and permit of its ready removal.

**DISPLAY DEVICE FOR WALKING FIGURES.**—I. A. ROMMER, 273 Van Sinderman Ave., Brooklyn, N. Y. This inventor has been granted two patents of a similar nature, which are intended more particularly for exhibiting walking dolls. The general object is to provide a stand of simple construction with means for supporting the toy and carrying the same forwardly, as well as means to be engaged by the feet of the toy for tripping or holding the same momentarily to simulate the walking movement as the toy moves forwardly.

**CALENDAR.**—P. S. HAUTON, 30 Church St., New York, N. Y. The particular object of this invention is to provide a perpetual calendar to be used on the end of a fountain pen, pencil or the like. A further object is to provide a construction which is simple while at the same time presenting a perfectly clear and intelligent arrangement by which any desired date may be quickly and easily ascertained.

**NURSERY CHAIR.**—W. W. CHRISMAN, 128 21st Avenue South, Seattle, Wash. The invention relates to a chair of the collapsible type. An important object is to provide means whereby the receptacle of the same may be effectively sealed, when it is not possible to empty the same immediately after the use of the chair. A further object is to provide a chair having simple means whereby



Fig. 1.—This method of weaving, invented by J. Feulner, prevents fraying of neckbands

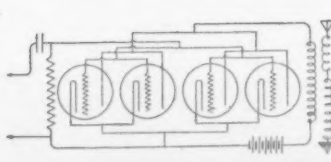


Fig. 2.—This novel wiring arrangement is the invention of J. W. Hill and makes for equal leads in radio sets

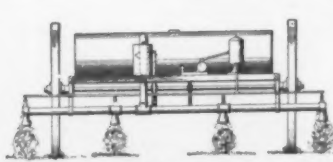


Fig. 3.—C. A. Wood has invented this spraying arrangement for treating plants with insecticide

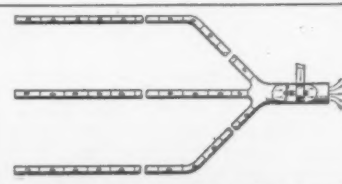


Fig. 4.—This air-conveying system, invented by L. M. Rowe, has for its object the offsetting of frost effects on plants

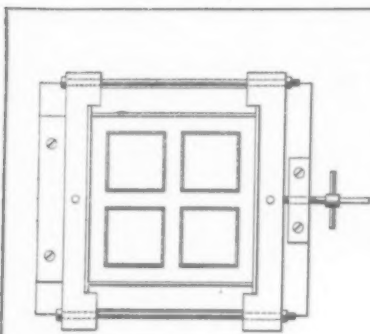


Fig. 5.—An ingenious press, invented by A. Mosblack, which serves especially to form cement tile

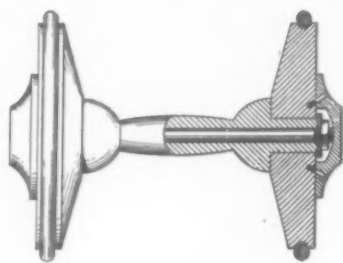


Fig. 6.—This special type of dumb-bell for exercising is the invention of L. W. Albizu



Fig. 7.—Placing an electric lamp on a costumer has been the basis of this ingenious invention of E. Goodfield

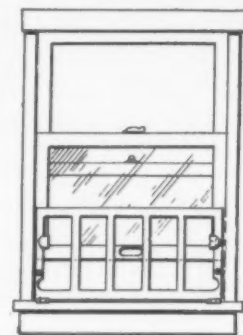


Fig. 8.—A simple window guard invented by H. C. Harper, which serves to prevent accidents

the legs, sides and back may be compactly folded for transportation, and which may be readily arranged in operative position without unnecessary inconvenience.

**JAR COVER AND GASKET.**—A. FOLTZ, Lambertville, N. J. The invention relates to closures for receptacles. Among the objects is to provide a jar and cover, formed respectively with co-acting gasket receiving seats which function to seal the cover to the jar, with the exertion of a minimum pressure. The invention further contemplates the provision of a tubular gasket to effectively seal the cover and jar, and to permit of ready removal of the cover.

**TILE PRESS.**—A. MOSBLACK, 228 No. 4th St., Steubenville, Ohio. The invention relates to a press having special utility in forming cement tile for floors, walls, mantles, moulding, caps, sills, lintels or other ornamental work in building structure, although the invention is useful in operating on other materials in producing different colors or embodying various designs. The general object is to provide a press having means for producing the article in one, two, three or more colors at one operation. (See Fig. 5.)

**EXERCISING APPARATUS.**—L. W. ALBIZU, Box 8, Ponce, Porto Rico. The invention relates to an exercising device, in the form of a dumb-bell, comprising a handle formed with a gripping portion, a pair of enlargements and a pair of stub shafts, the gripping portion, enlargement and shafts being integral, a rotatable disk, with a rubber tire, acting as a weight mounted on each of the stub shafts, and means for holding the disks on the stub shafts without interfering with their rotation. (See Fig. 6.)

**ILLUMINATED COSTUMER.**—E. GOODFIELD, 1483 Greene Ave., Brooklyn, N. Y. An object of the invention is to provide a device which will serve the double purpose of a costumer and a floor lamp, and at the same time serve to illuminate articles hung upon the costumer so that they may be readily located. The device is attractive in appearance, practical in construction, durable, inexpensive to manufacture, and may be illuminated by the ordinary house lighting circuit. (See Fig. 7.)

**WINDOW GUARD.**—H. C. HARPER, 706 Harrington Ave., Detroit, Mich. The invention relates to devices adapted for guarding windows when in open position against persons or objects entering or falling through, a purpose being the provision of a guard which is of extremely simple and inexpensive construction and which in applied position in a window is capable of occupying an inactive and active position in which it successfully spans an open window for the purpose described. (See Fig. 8.)

**LUMBER CALCULATOR.**—A. L. BECK, c/o Orlando Novelty Works, Orlando, Fla. The object of this invention is to provide a calculator which enables the user of ordinary intelligence to ascertain the number of board feet contained in any given dimensions without the necessity of carrying any tedious and difficult mathematical calculations or processes involving special knowledge and skill. A further object is to provide a calculator which is extremely simple, and of durable construction. (See Fig. 9.)

**REFRIGERATOR.**—L. LANZKRONER, c/o Supreme Refrigerator Co., 321 Avenue A, New York, N. Y. An object of the invention is to provide means whereby the drippings from a refrigerator can be very simply and efficiently collected and removed and whereby the spilling of the drippings on the floor is avoided. A further object resides in the provision of means whereby a maximum of storage space is provided, and

an exceptionally large ice capacity, whereby cracked ice and ice water can be had at all times, this arrangement being in the structure of the refrigerator itself.

**PRINTERS' QUOIN.**—G. DUNCANSON, JR., 94 Randolph St., Jersey City, N. J. Among the objects of the invention is to provide a quoin which after the same is set it may be locked to prevent accidental displacement of the parts when in use, and the locking means serves also as a means for retaining the wedge blocks against displacement when they are not in use, although the wedge blocks are freely movable when required.

**KEY RING.**—J. HUSAR, 6119 S. Kolin Ave., Chicago, Ill. An object of the invention is to provide a novel form of key ring in which means is provided for normally maintaining key in place thereon, while permitting removal of the keys at will. A further object is to provide a device that combines in one article means that render it particularly useful in the household and while traveling. The device comprises an angle shaped key ring, a bottle cap remover, a button-hook and a corkscrew.

**MANUALLY ACTUATED ACTION FOR FIREARMS.**—C. A. BRAUNGER, c/o J. H. Pruitt, Cissna Park, Ill. The object

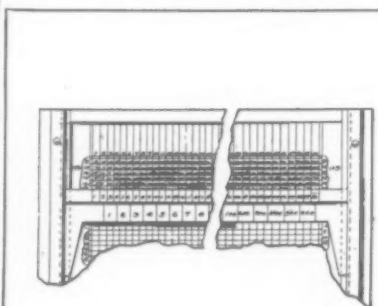


Fig. 9.—Much time is saved in figuring board feet by this lumber calculator invented by A. L. Beck

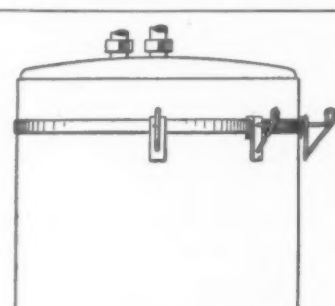


Fig. 10.—This rack, fitting around the usual hot-water tank, dries clothes, etc. Invented by F. C. Darling

of the invention is to produce a manually actuated action of simple construction, which comprises a casing, a trigger, a latch slidably mounted on the trigger, a hammer, means for retaining the hammer and trigger in their normal positions, and means for projecting the latch into engagement with the hammer to associate the trigger and the hammer during cocking action, said latch being released from the hammer for the firing stroke.

**IGNITION AND PROPULSION TUBE.** C. A. BRAUNGER, c/o J. H. Pruitt, Cissna Park, Ill. The invention relates to an ignition and propulsion tube for bombs. The object is to provide in conjunction with a missile containing an explosive charge a device containing means for igniting the charge, means for propelling the missile and operating the igniting means, and means for controlling the flight of the missile.

**CURTAIN HANGER.**—W. E. WROCINSKI, 2121 Thomas St., Chicago, Ill. An object of the invention is to provide a device in which the rods from which the curtains are suspended, may be lowered to permit the curtains to be placed thereon or removed without the use of a step ladder or the like. A further object is to provide a simple device in which a plurality of rods may be supported parallel to one another and lowered or elevated simultaneously.

**ADJUSTABLE LEG REST FOR CHAIRS.**—L. AIME, 309 Karrigan Ave., West Hoboken, N. J. Among the objects of the invention is to provide a leg rest more particularly for rocking chairs, formed to be extended to any desired extent when in use, and to be folded and shifted to a position for storage beneath the chair when not in use. The device may be locked in any of several adjusted positions, is simple, and may be easily connected or disconnected.

**COVER FASTENER FOR CONTAINERS.**—E. M. SEIFERT, 204 Hollister Ave., Rutherford, N. J. This invention contemplates, in addition to the usual bail and handle, means for fastening the cover of fruit baskets to the basket proper without injuring the contents, and at the same time preventing any possibility of separating the same when in transit. A further object is to provide an auxiliary fastening wheel which may be readily released without mutilating either the cover or the basket.

**PLY WOOD.**—O. P. CADMUS, c/o A. G. Hoe, 52 Gansevoort St., New York, N. Y. The invention relates to a "ply wood" which will incorporate fire-resisting qualities, for use in the building trades. The result is accomplished by providing a body which is chemically treated throughout the major por-

a disk calculator of this character especially adapted for converting units or numbers from one system of units, such as the metric system, into another system of units, such as the British or the United States system, or vice versa, without mathematical calculations, thus permitting the conversion to be made even though the operator does not possess any knowledge of the mathematics.

**GARMENT FORM.**—J. TEDFORD, c/o The Tedford Sleeve Form Co., 6625 Lakewood Ave., Chicago, Ill. An important object of the invention is to provide a sleeve form capable of use when draping coats on display stands, which may be readily inserted in the sleeve to give the sleeve the desired fullness both at its front and rear sides, and which will also prevent the adjacent portions of the coat from wrinkling.

**HORSESHOE.**—F. C. ROBERTSON, Spokane, Wash. The object of the invention is to provide a composite horseshoe of the cushioned type in which the force of impact and the tearing and major abrasive forces acting along the shoe are received by a metallic element, and thereby prevented from breaking down the cushioning element. A further object is to provide a horseshoe which is of simple, durable and lightweight construction.

**METHOD FOR MAKING OVERLAYS FOR PRODUCING HALF-TONE CUTS.**—ST. PAUL JOHNS, c/o W. E. Kennedy, Editorial Department, Pittsburgh Post, Pittsburgh, Pa. The purpose of the invention is to provide means whereby an overlay may be produced in a short time. The method consists in making an inked proof, powdering the same, then heating the proof a predetermined interval, and then dipping the proof in a solution of silicate of soda and water, and allowing the proof to dry.

**SUPPORT.**—F. C. DARLING, Walton, N. Y. This invention has for its object to provide a device which may be conveniently attached to a boiler and which will serve to support clothes or similar articles to be dried by the heat of the boiler. A further object is to provide a device in the form of a circumferentially adjustable ring having a plurality of individual supports, which will be simple and practical in construction and durable in use. (See Fig. 10.)

**ARCH AND ANKLE SUPPORT.**—H. A. BERNSTEIN, 115 W. 73d St., New York, N. Y. The object of the invention is to provide an arch and ankle support arranged to snugly fit the foot of the wearer with a view to firmly hold up the arch and to sustain the ankle without discomfort or impeding the use of stockings or shoes. Another object is to permit of readily placing the support in position on the foot.

**ORNAMENTAL BEADING FOR JEWELRY.**—G. G. M. F. HARTMANN, 32 Maroneck Ave., White Plains, N. Y. This invention has particular reference to the provision of supporting frames and structures for beading which may be used in connection with necklaces and similar devices. An object is to provide a simple and strong framework on which ornamental beading may be mounted in accordance with any particular design.

**KNOCK-DOWN CONTAINER.**—J. H. KILLION, 1628 Prairie Ave., Chicago, Ill. An object of this invention is to provide a knock-down container comprising relatively few parts which are interengaged to maintain the container in set-up or assembled condition. A further object is to provide a device that can be disassembled and the parts packed to occupy a small space, but will form a lightweight, durable container when set up.

**COMPOSITION FOR TREATING FABRICS.**—H. J. SCIB, 2008 Daly Ave.,

tion of its thickness for fire resisting, and a facing or veneer of wood which is non-fireproofed and which will provide a decorative surface, not possible on the fireproofed material.

**CODING AND DECODING DEVICE.**—A. NEWELL, 1302 Cadiz St., Dallas, Texas. The object of the invention is to provide a coding and decoding device comprising a body having a circular recess, the bottom of which is divided into segments containing code matter arranged to enable the user to quickly and accurately code and decode a message. Another object is to provide a device which is very simple and durable and not liable to get easily out of order.

**BANANA CRATE.**—P. G. HATCHER, c/o Hatcher Fruit Co., Jonesboro, Ark. The primary object of the invention is to provide a folding crate, especially adapted for shipping bananas, which may be readily collapsed so as to occupy a minimum of space when returned, at the same time be very economically produced as well as presenting a ready built construction which is both strong and durable to withstand rough usage in shipment and is provided with a top and bottom.

**TABULAR CALCULATOR.**—N. J. DEISCH, 1727 Kenyon St., N.W., Washington, D. C. The invention relates in general to tabular calculators, and more particularly to



Bronx, New York, N. Y. The invention relates to a method of treating a fabric for rendering the same translucent, and thus adapted for use in the manufacture of lamp shades. While the fabric is specially adapted for this purpose it is also capable of use in other connections. The composition consists of a mixture of gelatine, water, yeast and alum, the gelatine and water being first mixed and the yeast and alum added.

**LIFE PRESERVER.**—J. STROBEL, 11122 121st St., Glen Morris, L. I., N. Y. The invention relates to a life belt which includes an automatically filled air chamber. An object is to provide a form of valve for preventing the escape of air from, or the entrance of water into the chamber, and means for actuating the valve. A further object is to provide means permitting of rapidly donning of the belt, and for holding the belt in collapsed position when not in use. (See page 11.)

**CRATE OR BOX.**—G. A. McLEAN, 1420 E. 6th St., Little Rock, Ark. This invention particularly relates to the type of crates or boxes used for shipping fruits and vegetables. An object is to provide a crate of this character which can be folded so that empty crates will occupy a very small amount of space. A further object is to provide a crate which will be light in weight, strong and durable in use, simple in construction and inexpensive to manufacture.

**SUSPENSION RAFTER AND SUPPORT.**—D. HEUSINKVELD, Hull, Iowa. It is one of the primary objects of the invention to provide means by which the rafters of a hip-roof may be secured together at their joints without using nails or similar fastenings except to prevent relative movement of the members at the joint. It is a further object to provide means by which the joint may be tightened from time to time as conditions require. (See Fig. 12.)

#### Hardware and Tools

**CAN OPENER.**—G. ROUND, 594 Macon St., Brooklyn, N. Y. An object of the invention is to provide a can opener with an adjustable means which permits a circular section of the desired diameter to be cut from the end of the can, and hence, permits use of the device as a can opener for any ordinary diameter of can. A further object is to provide a can opener which is easy to adjust, and is inexpensive to manufacture.

**PLIERS.**—F. T. FOEHL, 36 Devoe St., Brooklyn, N. Y. The invention relates to pliers particularly adaptable for use in connection with optical work. The aim is to provide pliers which are extremely simple in construction, and by means of which an optician will be capable of accurately fitting the clamping arms of the nose pieces and other parts of the spectacle to the lenses, in such a manner that no play will come into being between these parts.

**PRUNING KNIFE.**—J. C. CASHMAN, 1653½ West Jefferson St., Los Angeles, Cal. The object of this invention is to provide a pruning knife which will be particularly effective due to the fact that the branch to be cut is firmly gripped by the stationary portion of the device on three sides so that firm resistance is offered to the cutting edge operating from the fourth side. A further object is to mount the cutting blade in such manner that it cannot become misplaced when under severe strain. (See Fig. 13.)

**SASH LOCK.**—G. ROUND, 594 Macon St., Brooklyn, N. Y. Among the objects of the invention is to provide a sash lock which not only effectively locks the sashes against

vertical movement, but is also burglar-proof and serves as an anti-rattler to prevent noises caused by the movement of the sash frames. The device will very effectively perform the functions for which it is intended and may be manufactured and sold at a reasonable price.

**HANGER FOR PORCH SWINGS.**—H. W. BEEM, 5 North Harrison St., Batavia, Ill. This invention has for its object to provide a device for suspending a porch swing or the like, in which the "squeak" normally found in such devices is entirely obviated. A further object is to provide an anti-friction bearing to permit a free oscillatory movement of the swing, and in which the rocker bearing support may be locked in adjustable position in alignment with the porch ceiling hooks and the grapple hooks on the swing.

**DOOR LATCH.**—V. J. WILLIAMS, 6044 Champlain Ave., Chicago, Ill. Among the objects of this invention is to provide a latch of relatively simple construction which may be operated by pushing or pulling on the knob, instead of by rotating, thus obviating the necessity of turning the knob, in case of a panic or the like, in a crowded theater. The device is positive in action, and not liable to easily get out of order.

**DRILL HOLDING AND RELEASING DEVICE.**—H. W. WATSON, 1098 Monroe Ave., Memphis, Tenn. The invention relates more particularly to what are commonly known as drill sockets. The primary object is to provide a drill holding and releasing device, through the manual manipulation of which a drill may be easily released, the release being accomplished by one hand only, leaving the other hand entirely free to hold the drill when released.

**PIPE WRENCH.**—R. O. ESHELMAN, Box 218, Hyde Park, Pa. The invention relates to a pipe wrench comprising a movable jaw having a shank, a separate handle constituting at its front end a fixed jaw, a U-shaped strap secured to the opposite side of the fixed jaw and pivotally connected at its one end to the fixed jaw, and connected to the fixed jaw at a point distant from said pivot, rack teeth on the shank, a pinion on the fixed jaw, and means to lock said pinion against rotation.

**METALLIC WASHTUB COVER.**—D. F. LOUDON, 109 W. 102d St., New York, N. Y. The object of this invention is to produce a metallic washtub cover which is exceedingly strong and not liable to warp or lose its shape even when weighted with cooking utensils or other articles. Another object is to prevent water or liquid from cooking utensils from running onto the floor, and to allow of conveniently cleaning the cover to keep it in a sanitary condition.

#### Heating and Lighting

**INCINERATOR.**—P. F. McMAHON, 431 Cherokee St., Bethlehem, Pa. Broadly this invention includes a fuel combustion chamber and a superposed reduction chamber with a suspended receiving and supporting means arranged therein to act as a container for the waste matter to be reduced whereby the same may be periodically oscillated to dislodge the ashes and present new layers of the mass to the action of the heat and flame. A further object is to provide means for preheating the waste mass to facilitate more rapidly the reducing action.

**PORTABLE INCINERATOR.**—C. W. ESHELMAN, 218 27th St., Newport News, Va. This invention relates to incinerators adapted to be applied to motor trucks, and thereby permit of the incineration of refuse while the vehicle is under way. It is also a

purpose to provide an incinerator which will effect the complete incineration of garbage to the extent that the fumes emanating from the incinerator will be odorless.

**OIL BURNER.**—F. JOHNSON, Box 111, Oakland, Calif. This invention relates to burners for cooking and heating purposes and is especially adapted for use in burning oil, the object is to produce a cheap, simple and efficient means for utilizing a cheap grade of liquid fuel, such as kerosene. A further object is to construct the burner in such a manner as to off-set the danger of using the same due to explosion or other causes present in utilizing combustible liquids as a fuel.

**FUEL SAVING DEVICE FOR HEATERS.**—H. B. MAYNARD, Sr., 117 Nevins St., Brooklyn, N. Y. An object of the invention is to provide an automatically operable means associated with a gas stove or heater which is operable by the weight of the utensil or other article to be heated when arranged on the stove, to effect a full flow of gas to the burner, and upon the removal of the utensil, to effect a substantial reduction in the flow of gas whereby to overcome a considerable waste of fuel.

#### Machines and Mechanical Devices

**CAPPING MACHINE.**—G. LOCHHEAD, 2301 Huron St., Los Angeles, Cal. The invention aims to provide a device of this character, more particularly adapted for use in connection with the application of tops to cans, and which is primarily devised with a view to producing a machine capable of being operated by hand for household use, and capable of effecting a capping of various sized receptacles, the curling and compressing action being accomplished by the same machine.

**WOOD-CARVING MACHINE.**—W. B. YOUNG, c/o Chicago Civic Opera Assn., 1701 Wabash Ave., Chicago, Ill. An object of the invention is to provide a machine having means for effecting duplicate carving simultaneously on a desired number of articles arranged in a plurality of groups or sets of four articles each. A further object is to provide means for holding the articles in adjusted positions with respect to one another and to the carving tools.

**ARRANGEMENT FOR BREAKING AND LOADING COAL IN COAL MINES.**—S. O. FOSS, c/o Bryns Patentkontor, Tostrupgaarden, Christiania, Norway. This invention has for its object a method and arrangement for mechanically breaking and loading coal and is adapted for thin seams; it comprises a coal cutting and loading machine and a chain mounted in an undercut along a seam wall, said chain being engaged by the cutting and loading machine for enabling the same to perform a feeding movement.

**GRINDING MILL.**—J. B. SEDBERRY, c/o The Bossert Corp., Utica, N. Y. A purpose of the invention is the provision of a mill having rotatable grinding elements arranged in sets of three or more so as to cause a mutual coaction of the elements of all the sets to effect a grinding of the material quickly and efficiently and with a minimum consumption of power. The grinding elements are supported for automatic adjustment to vary the grinding action.

**THREAD GUIDE FOR REWINDING MACHINES.**—E. E. KAUFMAN, 513 Prescott Ave., Scranton, Pa. The invention particularly relates to guides for thread rewinding machines and has for an object to provide a construction which will not become disengaged but which is free to operate for

the purpose desired. Another object is to provide a thread guide which is resiliently held in place while permitted a free rotary movement.

**TILE PRESS.**—C. A. LANDBACK, c/o Pardee Tile Works, Perth Amboy, N. J. The object is to provide a construction wherein power may be used to perform the pressing operation without endangering the workmen or the apparatus. A further object is to provide a power driven press wherein the power is turned on manually and turned off automatically, the structure being such that in case the manual operating means is released, the automatic action will function.

**WELL MEASURING APPARATUS.**—R. C. MASON, 505 Central Natl. Bldg., Tulsa, Okla. Among the objects of the invention is to provide a well measuring apparatus in which the cable and driving wheels are positively constrained to corresponding motion, the cable being held at all times in driving engagement with the driving wheels and the driving wheels being governed to preclude their overrunning the cable.

**ROAD BUILDING MACHINERY.**—C. D. FARMER and H. L. LIBBY, City Hall, Eugene, Ore. The invention has for its object to provide a method and apparatus in which the roadway may be provided with a new surface completely covering the old roadway and filling all ruts and breaks so as to present a smooth surface, and in which the resurfacing is carried out expeditiously and with a minimum of handling of the material and a minimum expenditure of labor.

**FORM FOR MOLDS.**—H. R. SUITER, Red Lodge, Mont. The invention relates to forms especially adapted for use in building construction. An important object is to provide a form for concrete walls which may be easily and quickly moved and reset for the continuation of the wall and which will require a minimum of material. The form is of simplified construction, durable in use and inexpensive to manufacture.

**WASHING MACHINE.**—H. W. WHITE, 837 W. 6th Ave., Emporia, Kan. An important object of the invention is to provide a washing machine having a depending receptacle which constitutes a sediment collector and which is separated from the main washing chamber by means of a baffle plate and the annular base plate constituting a means for maintaining the water and the dirt in the sediment collector in an unagitated state.

**LAWN-MOWER CUTTER.**—C. B. ENGLISH, JR., 15 May St., Newark, N. J. The invention has for its object to provide a construction which works in a very efficient manner without requiring any unusual attention. A further object is to provide a cutter for lawn mowers in which the cutting blades are so formed as to overlap the cutting bar at two points to a sufficient extent to allow the succeeding blade to engage the bar before the preceding one has left the same, whereby injury to the blade and noise is prevented.

**MEANS FOR CONTROLLING THE GAS PILOT LIGHTS OF WATER-GAS MACHINES.**—T. S. BARLOW, Twenty-first Street and Avenue A, New York, N. Y. Among the objects of the invention is to provide means whereby the flow of gas to the pilot light may be controlled by interconnecting mechanism operated by the means employed to open and close the stack valve, so arranged that as the stack valve is opened the flame of gas to the pilot light will be increased, and when the stack valve is closed



Fig. 11.—J. Strobel has invented this new form of life preserver which has several advantages over more conventional devices.

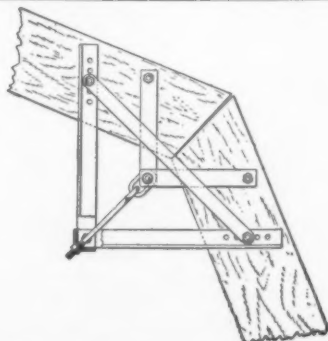


Fig. 12.—This ingenious method of joining the rafters of a hip roof is the invention of D. Heusinkveld.

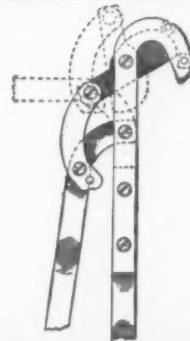


Fig. 13.—Holding the branch in a tight grip and cutting with a positive motion, this pruning knife is the invention of J. C. Cashman.

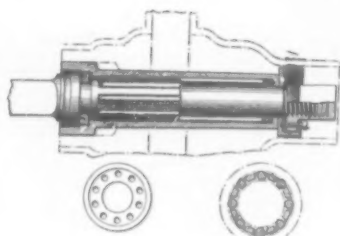


Fig. 14.—Several features of novelty distinguish this roller bearing, invented by L. S. Aldridge, from others.

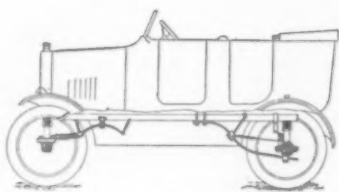


Fig. 15.—J. W. Gooch is the inventor of this improved shock absorber for automobiles.

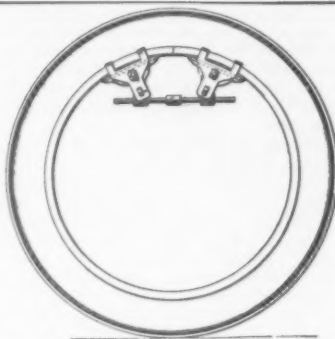


Fig. 16.—This simple device serves to reduce or expand the usual tire rim. It is the invention of J. R. Abercrombie.



Fig. 17.—Although having the general appearance of an airplane, this invention of G. R. Smith is in reality an improved form of motor-driven sleigh.

the flow of gas to the pilot light and the flame produced thereby will be decreased.

**DEVICE FOR VENDING SANITARY TOILET-SEAT PADS.**—H. H. SOMMER, 1703 Regent St., Madison, Wis. An object of this invention is to provide a vending machine having a compartment adapted to receive a plurality of superposed articles such as water closet-seat pads, and having means operable when a coin is deposited in the machine to eject the lowermost article from the compartment. A further object is to provide a device which is relatively simple and practical commercially.

#### Pertaining to Vehicles

**ROLLER BEARINGS.**—L. S. ALDRIDGE, c/o Pleasant View Farm, Chazy, N. Y. The invention relates to roller bearings for wheel axles. An object is to provide a roller bearing in which the rollers are carried by a cage and provides means for locking the cage within the axle box or sleeve, so that there is no danger of losing the roller bearings when the wheel is removed from the axle. Another object is to provide a bearing which will be simple and strong, and will require very little attention. (See Fig. 14.)

**AUTOMOBILE LOCK.**—J. C. GAYNOR, 125 Kearney St., Paterson, N. J. Among the objects of this invention is to provide a construction designed to be easily applied to the steering post in such a manner as to be locked merely by pressure of a hand, while a special key is necessary for unlocking. In case of disarrangement or jarring loose of any of the locking mechanism a spring means may be utilized for automatically moving the locking bolt to an unlocked position.

**BUMPER FOR AUTOMOBILES.**—F. F. ALEXANDRE, c/o Motor Kleen Corp., 398 Jackson Ave., Long Island City, N. Y. The invention relates to bumpers and locks for automobiles and particularly to a construction wherein the parts may be adjusted to act solely as a bumper, or may be adjusted to act principally as a lock for preventing theft. An object is to provide a vertical swinging bumper with wheel interlocking ends and a locking mechanism for locking the bumper against movement when swung to a position in engagement with the front wheels.

**RADIATOR PROTECTOR.**—R. L. COWLES, Canton, Conn. An object of the invention is to provide a protector which will prevent the liquid in an automobile radiator from freezing in cold weather, and will effectively screen the radiator from the wind. A further object is to provide means to facilitate the rapid attachment or removal of the device from the radiator.

**DEMOUNTABLE RIM.**—H. M. HOWELL, c/o Sam Kaplan, c/o Instant Changeable Tire and Rim Company, Monroe, La. The object of the invention is to provide a rim adapted to be utilized in conjunction with a spare tire pumped up and ready for service whereby any driver of an automobile or other vehicle may effect a change of tires without the necessity of exercising a great degree of mechanical skill or of expending a great degree of work or strength in order to carry out the operation.

**BRACING DEVICE.**—L. C. ROSS, Killdeer, N. D. The important object of this invention is to provide reliable means for bracing the front cross member of the frame of a Ford car. A further object is to provide a bracing device of the character specified with simple means whereby it may be attached to a Ford car without substantially altering the construction of the vehicle.

**LOCKING DEVICE.**—R. SPENCER, c/o Spencer-Ayer Co., Inc., Walnut Creek, Calif. Among the objects of the invention is to provide a device by which the inlet and the discharge of an automobile tank can be selectively closed and opened and can be secured in either position by means of a lock requiring a special key to change its position. Thus the automobile can be made practically burglar-proof.

**FLUID CLUTCH AND TRANSMISSION.**—E. R. CARPENTER, 303 American National Bank Building, Oklahoma City, Okla. This invention relates more especially to the transmission of power in connection with automobiles and other motor cars. The primary object is the provision of an arrangement by which the usual functions of the ordinarily separate transmission and clutch may be combined in a single strong, durable and effectively operating apparatus which will permit of a wide range of variation in speed and power depending upon the requirements.

**SHOCK ABSORBER.**—B. G. VON ROEDER and E. C. OATES, 825 Chronicle Bldg., Houston, Texas. An object of the invention is the provision of a device which is primarily intended for use as a connecting and cushioning medium between the upper and lower springs commonly employed under automobiles, or between the upper spring and the axle, or between a spring and the frame of an automobile. A further object is to provide a shock absorber which will be practical, strong and readily substituted for the ordinary links now employed in this connection.

**VEHICLE TOP SUPPORT AND HOLDER.**—H. J. McCAFFERTY, 281 Sanford Ave., Flushing, N. Y. The invention relates to bodies for vehicles and pertains more particularly to brackets for holding the tops of bodies when the tops are in their folded position. The primary object is to provide a top holder in which the holder may be removed when not in use, and a novel form of clamping means for the holder.

**FENDER FOR MOTOR VEHICLES.**—L. MEHLBERGER, 451 Concord Ave., Detroit, Mich. The object of the invention is to provide a fender for motor vehicles which is normally disposed in an out-of-the-way position and automatically brought into operative position by virtue of an actuating means upon contact of said means with a pedestrian. The invention further contemplates means operable upon the movement of the fender to operative position for automatically applying the brakes of the vehicle.

**COMBINED TIRE GAGE AND ENGINE COMPRESSION GAGE.**—H. A. WALKER, 142 Panama Ave., San Antonio, Texas. An object of the invention is to provide a gage which will accurately indicate the compression in pneumatic tire, or the compression obtained in an engine cylinder, and in which the indicating stem is held positively in any position to which it has been moved by pressure, so that it may be read at leisure and restored to its normal position.

**LOCK.**—T. KNIGHT, 52 West Lake Ave., Atlanta, Ga. An important object of the invention is to provide an automobile lock which may be conveniently applied to the steering post, so that the same will prevent the steering post from being turned by an unauthorized person. The device is neat in appearance and does not interfere with the steering of the vehicle by the authorized operation.

**THEFT PREVENTING DEVICE FOR VEHICLES.**—J. A. JOHNSON and J. P. THOMPSON, Box 7, Leavenworth, Kan. The

object of this invention is to provide a device which may be locked to shut off the fuel supply and preclude operation of the engine by an unauthorized person, but which may be easily released by an authorized person to permit the free flow of fuel and operation of the vehicle, which is simple, durable, reliable in operation and inexpensive to manufacture and apply.

**DRAWBAR CARRIER.**—I. N. JONES, Box 372, Santa Paula, Cal. Among the objects of the invention is to provide a carrier which is adapted to be attached to the frame of a tractor of conventional construction or like vehicle and to coact with the draw bar in such manner as to hold the draw bar out of contact with the vehicle frame while permitting of movement of the draw bar about its connections with the tractor frame into various angular relations to the longitudinal axis of the vehicle frame.

**SYSTEM OF ELASTIC LATERAL BALANCING FOR VEHICLES.**—P. J. LEBOUCHER, 19 Rue Theodore de Banville, Paris, France. The invention relates to a system balancing devices, each comprising telescoping and spring pressed members for vehicles with bogies interposed laterally between the bogie frame and the body of the vehicle for the purpose of damping the oscillations of the latter and imparting to it by an adequate compensating couple the stability necessary for good normal running.

**AIR PUMP.**—A. MARSHALEK, c/o Beeton, Dickenson & Co., Rutherford, N. J. The object of the invention is to provide an air pump more especially designed for use by autoists to enable the user to conveniently actuate the pump to quickly inflate a tire without requiring undue physical exertion. Another object is to permit of temporarily attaching the air pump to the running board of the automobile thus enabling the user to conveniently actuate the pump.

**THIEF SIGNAL.**—L. FRIED, 321 Stone Ave., Brooklyn, N. Y. The invention relates to means for indicating whether or not the car has been stolen. The object is to provide a simple and effective construction which may be readily seen and which will indicate that the car is being operated by an unauthorized person, and will present a breach of police regulations by the cancelling of the numbers of the license plate without obscuring the same.

**HEADLIGHT SHIELD.**—C. L. SIMON, 117 Third Ave. East, Grand Rapids, Iowa. An object of the invention is to provide headlight shields of the type of construction in which a plurality of telescopically arranged sections are supported for movement across the face of a headlight casing, and in which means are provided for positively operating the shield members from the body of the vehicle carrying the headlight, to shield the upper portions of the lights and cut off as much of the light as desired.

**SEAT CONSTRUCTION.**—G. V. BARNES, 985 Park St., Alameda, Cal. The invention relates in general to seats for vehicles, street cars and other conveyances, and has reference more particularly to a seat mounting or suspension. The primary object is to provide means for absorbing, so to speak, the lateral jolts and shocks experienced in a vehicle which are not ordinarily taken up or absorbed by the springs of the vehicle or the customary cushion springs.

**TIRE RIM.**—D. MORIARTY, 10,009 East 14th St., Oakland, Cal. The particular object of the invention is to provide a rim which allows of ventilation of the inner tube whereby the latter is prevented from overheating. A novel feature of the device consists in the perforation in the central por-

tion of the rim channel, which allows air to circulate around the tube, which circulation increases as the speed of the vehicle increases and serves to keep the tire cool.

**SHOCK ABSORBER.**—J. W. GOOCH, Shamrock, Texas. An important object of this invention is to provide a shock absorber having means whereby the rebound of the springs of a motor vehicle and the consequent discomfort to the occupants may be reduced to a minimum. A further object is to provide a shock absorber having means whereby the same may be applied without substantially altering the construction of the vehicle. (See Fig. 15.)

**VEHICLE WHEEL.**—H. C. DAUPHINATIS, 2020 Front St., Fargo, N. D. The object of the invention is to produce a wheel that will absorb jars without the use of pneumatic tires. The object is attained by having a wheel structurally built in two main sections, the hub and the rim; intercommunicating pneumatic cushions to support the two sections, and sliding guides pivotally connected in their center to guide the two sections in relation to each other.

**GAS PRODUCER.**—D. J. SMITH, c/o International Gas Producer Co., 295 Fifth Ave., New York, N. Y. The invention relates to means for feeding the fuel to the producer in and connected with gas producers for propelling vehicles. The object is to provide means for supplying the fuel to the producer from a hopper which may be formed in or on the canopy or cover over the head of the driver, and embodied therewith are means for readily displacing and replacing the feeding means when it is desired to inspect or start the same.

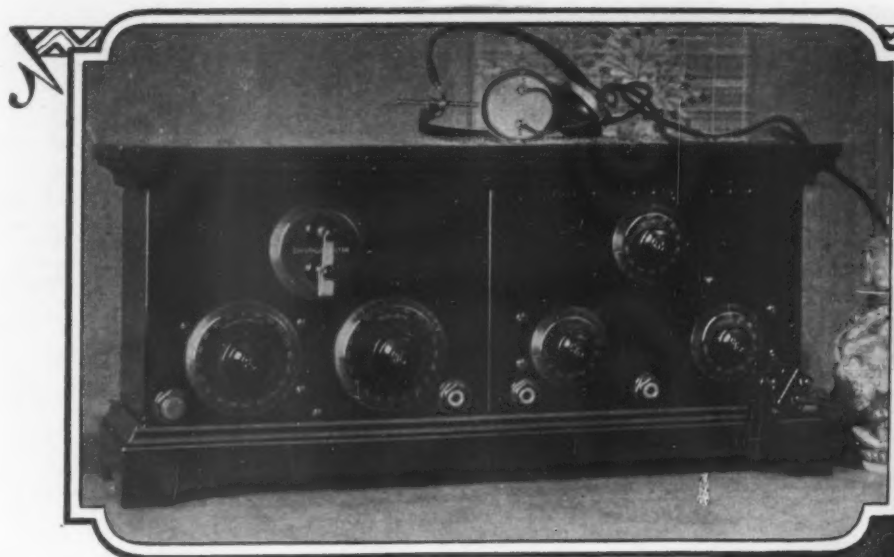
**RIM REDUCING AND EXPANDING IMPLEMENT.**—J. R. ABERCROMBIE, Siloam Springs, Ark. The object of the invention is to provide an implement which will not only reduce the usual split rim and hold the same in reduced position during the removal and replacement of a tire, but will also be equally effective in expanding the rim to the normal position after a tire has been placed thereon. A further object is to provide an implement which may be readily applied to and removed from a rim, and will be simple, strong and effective in use. (See Fig. 16.)

**WHEEL AND AXLE ASSEMBLY.**—J. A. DAUGHTERY, c/o Wayne Agricultural Works, Goldsboro, N. C. The invention relates to wheel and axle assemblies especially adapted for use on trucks. The object is to provide an assembly which is dust proof, and which includes a flange nut, together with an annular flange for preventing ingress of dust. The device may be readily constructed and at the same time prove reliable and durable in use.

**AUTOMOBILE HEADLIGHT.**—G. A. ROBERTS, c/o Roberts Garage, Manchester Center, Vt. The invention relates generally to automobile headlights and more particularly to non-glare headlights, the object being to throw the maximum light upon the roadway in advance of the headlight, without glare, and still permit the use of a clear glass front plate in order that maximum light from the bulb will be utilized.

**MOTOR SLEIGH.**—G. R. SMITH, Killgore, Idaho. This invention has for its object to provide a sleigh in the form of an airplane which is propelled by an engine, the puller type of propeller being mounted on the forward end of the sleigh. A further object is to provide a motor sleigh with a construction of steering means and brake mechanism, and shock absorber mechanism, and one which will be comfortable and safe in travel over any kind of snow whether soft or packed. (See Fig. 17.)



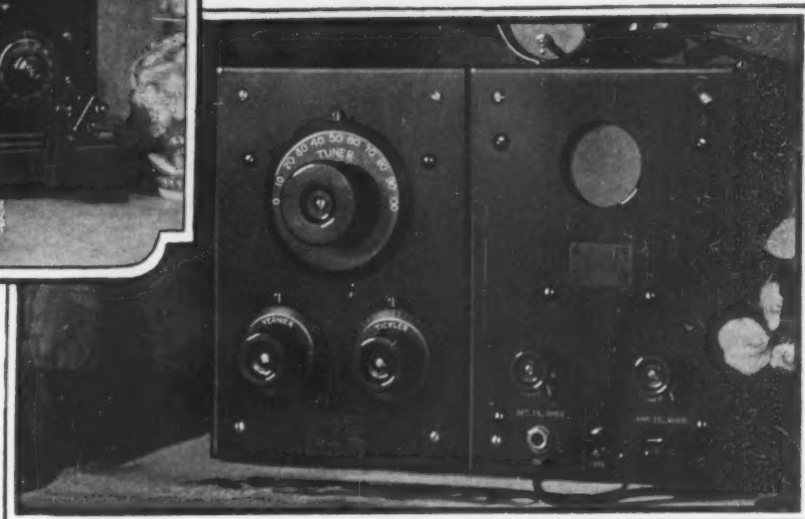


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## Why they stick

On the ground floor of the telephone building a man worked at the test board. It was night; flood had come upon the city; death and disaster threatened the inhabitants. Outside the telephone building people had long since sought refuge; the water mounted higher and higher; fire broke out in nearby buildings. But still the man at the test board stuck to his post; keeping up the lines of communication; forgetful of self; thinking only of the needs of the emergency.

On a higher floor of the same building a corps of telephone operators worked all through the night, knowing that buildings around them were being washed from their foundations, that fire drew near, that there might be no escape.

It was the spirit of service that kept them at their work—a spirit beyond thought of advancement or re-

ward—the spirit that animates men and women everywhere who know that others depend upon them. By the nature of telephone service this is the every-day spirit of the Bell System.

The world hears of it only in times of emergency and disaster, but it is present all the time behind the scenes. It has its most picturesque expression in those who serve at the switchboard, but it animates every man and woman in the service.

Some work in quiet laboratories or at desks; others out on the "highways of speech." Some grapple with problems of management or science; some with maintenance of lines and equipment; others with office details. But all know, better than any one else, how the safe and orderly life of the people depends on the System—and all know that the System depends on them.

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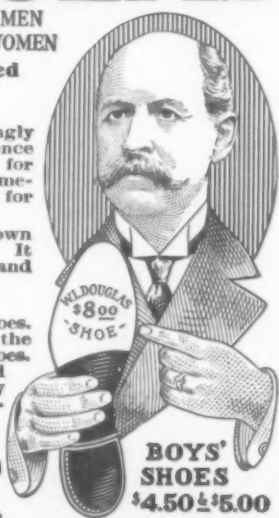
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### Death of Professor E. E. Barnard

THE noted senior astronomer of the University of Chicago, Professor Edward E. Barnard, passed away on February 6 at the Yerkes Observatory, Williams Bay, Wis. Death raced with the scientist who was working to finish the final chapter of his "Atlas of the Milky Way." Professor Barnard had a lingering illness, but he hoped to complete his great work. However, and fortunately, it is in such shape that his demise will not impair its usefulness.

Professor Barnard had spent 28 years of his life at the Yerkes Observatory. He first became interested in astronomy while he was an apprentice to a firm of English photographers in the old days of the Daguerrotypes and wet plates. His duties required him to reflect sunlight into the studio by a mirror, and this gave him his ideas of the sun's movement. He studied all the books he got access to and finally studied in a systematic way at Vanderbilt University. He became an associate astronomer at the Lick Observatory in California until he was called to the Yerkes Observatory where he remained for the balance of his life. His researches on the milky way will give him an enviable position in the astronomical wall-halla.

### Death of Professor Roentgen

WE well remember the day in 1895 when the news was cabled over that a German professor had made a discovery by which it was possible to see the bones in human beings and animals and even to photograph the same. The story was received with great incredulity and we were besieged by requests for the confirmation of the discovery. One of the editors of the SCIENTIFIC AMERICAN, the late George M. Hopkins, who was a physicist of note, tried a number of experiments in his laboratory and without very definite data to go upon, obtained results which warranted this journal in coming out and making a decided stand for the new discovery. The world was soon as much interested as we are in the great Egyptian tomb of today.

The man who made this epoch-making discovery which has saved thousands of lives and mitigated untold suffering recently died in Munich, at the age of 77. Wilhelm Conrad von Roentgen was born in Lennep, Prussia, in 1845 and studied in Holland and at Zurich, where he took his doctor's degree in 1869. He became a professor in physics at several German Universities and finally went to Wurzburg in 1885 where ten years later he made the discovery by which he will always be remembered—the Roentgen rays, commonly known as X-rays. He gave his discovery freely to the world and soon surrounded himself with special students of such high caliber that the new science progressed by leaps and bounds, so that in 1900 a Roentgen Ray Congress was held in Paris and he received the Nobel prize for physics. While, of course, the X-rays are used more largely in medicine and dentistry, nevertheless industrial uses were found at once for testing and analyzing all kinds of material as well as for the detection of smuggled articles.

A member of our staff who died only last summer, the late Professor Peckham, once made an X-ray of a "perpetual motion" device, which was submitted to us on condition that the box or base should not be opened. But the penetrating X-rays disclosed the fraudulent mechanism within.

Professor Roentgen made other investigations and discoveries of real importance, including elasticity, capillarity, the conduction of heat in crystals and the absorption of heat rays by different gases. No physicist has a greater reputation, and his natural modesty, which is usually inherent in the true man of science, kept him out of the public eye until his recent death.

### Power From River Jordan

THE hydroelectric development of Palestine was discussed recently at the second annual dinner of the Palestine Development Council by Dr. L. C. Lowenstein, consulting engineer of the General Electric Company. Dr. Lowenstein said that the Rutenberg project for generating and supplying electrical power in Palestine by utilization of the waters of the River Jordan had been investigated by a number of engineers. The Rutenberg plan is to utilize the falls of the River Jordan between Lake Tiberias and Jisr-el-Mujamieh. The treasurer of the company stated that he had been convinced from a recent trip to Palestine that the Holy Land could maintain three or four times the present population if irrigation were supplied.



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## Science Notes

**Barnacles on Whales.**—It is perhaps not generally known that whales acquire barnacles the same as do ships, but the kind of barnacle is different. The barnacles on whales do not seem to cause much discomfort, and probably no whale will ever go into dry dock to be scrapped.

**One Hundred Years of "The Lancet."** That conservative paper called *The Lancet* and often referred to as the *London Lancet*, has just completed one hundred years of existence and we have maintained an exchange with this journal for nearly fifty years. It is excellently edited and is interesting as well, which most medical papers are not.

**When Perfumes Were a Luxury.**—Perfumes first were used only in religious services and were consecrated to this use. The world has come a long way from the time when any other use was considered a sacrilege. The industry is a very old one. The caravan which brought Joseph as a captive into Egypt was engaged in carrying perfumes from Persia. A treatise on perfumes has been found written by a Greek scientist more than 300 B. C.

**Only Six Minutes of Sunshine in a Week.**—The records at Greenwich showed that London and adjacent territory had only six minutes of sunshine in seven consecutive days last November. The terrible results of this loss of sunshine through fog and smoke are clearly reflected in the rise of the London death rate during the period to 13.3 per thousand. One day of dense fog costs Londoners nearly \$5,000,000 in extra lighting, loss of wages, cost of delay, extra transportation and extra laundings.

**A Septuagenarian Alchemist Goes to Jail.**—An aged alchemist erected a lighting rod outside his bedroom window. He covered it with aluminum paint and insisted that he was collecting "sun fluid," which he succeeded in bottling and selling through a druggist friend for six francs a bottle. The French are rather gullible where medicines are concerned and they readily fell for the swindle. Finally, the local doctors found their practice dwindling so they had the "Helioline" analyzed with the result that the would-be alchemist landed in jail.

**The Exploitation of Gelatin.**—The Edible Gelatin Manufacturers of America, Inc., announces, according to *Science*, the establishment of an industrial fellowship in the Mellon Institute of Industrial Research of the University of Pittsburgh, for the purpose of ascertaining the real food value of edible gelatin in its manifold applications in the American dietary. In addition to experimental investigations, a correlation of available facts regarding edible gelatin will be made, to be held at the disposal of all users. The present incumbent is Dr. Thomas B. Downey, who will be glad to furnish information to those interested in the uses of edible gelatin.

**A Columbus Beacon Fund.**—We contribute to all kinds of enterprises and memorials so we are not surprised to hear of a revival of a plan to erect a memorial lighthouse in honor of Christopher Columbus. The project to erect a Columbus Lighthouse Memorial in Santo Domingo, where, many historians contend, the remains of Columbus lie, is not a new one. It originated before the World War, but was temporarily abandoned during the conflict. As previously announced, the memorial would take the form of a massive tomb, its exterior patterned after the lines of Grant's Tomb in New York. On the top of the tomb would be a beacon tower about 300 feet high, in the top of which would be a great light as an aid to navigation.

**A Collector of Fossils at 87.**—A lady resident of South Hadley, Mass., is a devoted student of geology and has made a specialty of collecting fossil footprints all her life. Her 87 years makes no difference in her eagerness for new fossil slabs. Miss Edwards was at one time an instructor in geology in Mount Holyoke College. She says: "My soul was much wrought upon by the matter of tracks. I looked abroad over the Connecticut Valley, and imagined the scene as it might have been ages ago, when the long extinct animals of those times walked the shores of the ancient lake and left their footprints on the shifting sands. I grew indignant and said to myself, 'When Professor Hitchcock comes for his lectures I'll take him down to the basement of the library and ask him if it isn't a shame that Amherst has so much and we so little! Tracks I must have.'"

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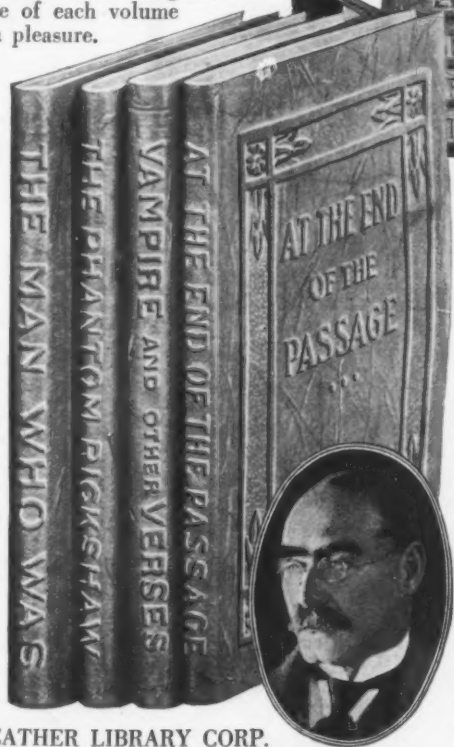
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## Science Notes

**Cattle Coin Collectors.**—Bullocks belonging to a butcher of Kent, England, have been engaging in coin collection, and their owner, according to the *London Referee*, continues to find old coins in the stomachs of bullocks slaughtered after grazing on the Sheppey Marches. They are all ancient coins, and those obtained from different animals bear dates of 1795, 1674, 1806 and 1727.

**Columbus's Expenses.**—A Berlin mathematician with spare time on his hands has figured out that the cost of the expedition of Columbus when he discovered America amounted to about \$7250. Of this amount Columbus himself received \$320, the captains of the other two ships got \$180 each and the sailors about \$29. The equipment of the vessels was \$2825.

**A New Element Hafnium.**—We understand that *Nature* reports a new element discovered by two Danes, Professors D. Coster and G. Hevesy and it has been named Hafnium. The discovery was made by an X-ray spectrum analysis of ore containing the metal known as zirconium, which is closely allied to the elements thorium and cerium, both of which are used in the manufacture of gas mantles. So far the new element hafnium has not been isolated. Experiments, however, are now being carried out with this object.

**The Universal Basswood.**—Have you ever noticed the white, clean appearance of the wood used for butter and candy pails and for the boxes in which comb honey is sold? It's basswood, one of the few species in the world that combines with its white color and light weight the qualities of being odorless and tasteless. Over 525 unique uses for which basswood is highly prized are enumerated in Department Bulletin 1007. Utilization of Basswood, a professional paper just issued by the United States Department of Agriculture and written by Warren D. Brush of the Forest Service.

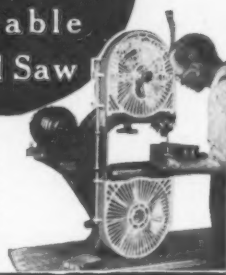
**Germanium in Medicine.**—Public announcement of the discovery of therapeutic properties in the chemical element known as "germanium," which, he said, promised to be of great value in the treatment of "secondary" anemia, was made recently by Dr. John H. Mueller, professor of chemistry at the University of Pennsylvania. Dr. Mueller told of his discovery at a recent meeting of the Philadelphia section of the American Chemical Society. Clinical application of germanium already has been made in local hospitals, it was stated, and physicians who observed its effects in cases of anemia caused by loss of blood and in "secondary" anemia declared that it was superior to any other known remedy. In cases of pernicious anemia, however, it was said to have given only temporary relief.

**A New National Monument.**—President Harding's recent proclamation creating a national monument embracing the newly discovered Timpanogos Cave in American Fork Canyon, seven miles east of American Fork, Utah, marks a new step in public recognition and use of a region rich in natural beauty and attraction, says the Forest Service, United States Department of Agriculture. Discovered in 1921, the cave was partially developed by officers of the Forest Service, but, as their explorations opened up new chambers and passages, the people of American Fork became interested and made available nearly \$2000 to place substantial ladders and guard rails and to illuminate the cave by the installation of an electric lighting system. Last season the beauties of the cave were enjoyed by enthusiastic thousands, the daily attendance frequently ranging into the hundreds.

**The Unhappy Remains of Columbus.**—A report has been made to the War Department by the Receiver General of Dominican Customs, dealing with the remains of Columbus. A project is now on foot to erect a massive tomb in San Domingo City, somewhat modeled after the tomb of Napoleon in Paris and the exterior something like Grant's Tomb in New York. A beacon tower 300 feet in height is part of the plan. Unfortunately the bones of Columbus which were brought from Spain in 1540 were often opened for inspection to distinguished visitors. This should be stopped. It was that very fact which first suggested the idea that it should be the concern of Pan Americans, the peoples of the 21 republics occupying the territory of North and South America and Canada to provide a suitable memorial and final resting place for Columbus in the Cradle of America, as Santo Domingo is called.

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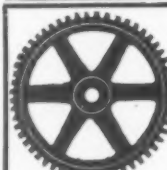


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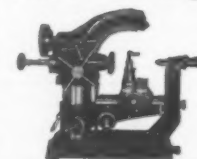
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## Miscellaneous Notes

**Milan Was the Former Style Dictator.**—Before Paris became the Mistress of Modes Milan gave the fashions to the world; hence the name "milliner."

**Motor Club Has Cycle Squad to Pick Up Broken Glass.**—The Chicago Motor Club maintains a fleet of motor cycle riders who respond to calls from all parts of the city to gather up broken glass on the streets.

**The Old Canal Bulkhead in New York.**—In cutting through on the south tube of the Hudson River Vehicular Tunnel the workmen recently struck an old bulkhead which was built in 1820 and used as part of the square inclosure which protected the mouth of the old Canal Street canal.

**All Panama Canal Records Were Broken in November.**—All previous records for the number of ships passing through the Panama Canal in one month, as well as for tolls collected, were broken in November. Reports show that 312 vessels used the waterway. The tolls amounted to \$1,264,441.

**The Airplane in Prospecting.**—The airplane is being largely used in Canada for prospecting as well as in other fields dealing with natural resources. The distances are so great that it has proved a speedy means of transportation and a great aid to reconnaissance as well. Dog sleds and portages have seen their best days.

**Selective Mail Boxes.**—Double mail boxes for the separation of local and out-of-town mail are being gradually introduced in Washington, D. C., as a test. The results so far show an efficiency of 94 per cent. The Department is going ahead with designs for a single box with two compartments which will be used in all large cities if the experiment continues to pan out well.

**Paris to Use Subways for Removing Rubbish.**—To relieve the traffic congestion in Paris attempts will soon be made to use the existing subways for the removal of bricks when buildings are demolished. Special trucks will be constructed which will be held in reserve in the subways and will be used only at night during the time when the subways are closed to the public. During the day the material to be hauled away will be dumped in a convenient place near by a subway entrance.

**Uncle Sam's Largest Payroll.**—The United States employs 252,756 people in the regular post office department, and 80,485 persons are indirectly connected with the big business of mail communication. It might be asked what the 80,485 persons do. These are clerks at third and fourth class offices, mail messengers, screen wagon contractors and employees, carriers for offices having special supply, clerks in charge of contract stations, star route contractors and steamboat contractors and their employees.

**Photography Solves the Problem of Food Repeaters.**—At one of the relief stations on the Asiatic side of the Ural Mountains, the Supervisor of the American Relief Administration has adopted a novel plan to prevent persons receiving the same package over again. The packages are purchased by remittances sent by friends and relatives, and in addition to taking a receipt from the consignee, a snapshot is taken of the persons receiving the packages, and the photographs are forwarded to the remitter along with the receipt.

**To Print a Real Newspaper at Sea.**—The *Daily Mail* has announced that beginning in February "an Atlantic edition" of that journal will be printed and published aboard the great Cunard liners running between England and New York and other North Atlantic ports. It will absorb the present daily bulletin issued by the Cunard company and will be edited aboard by experienced journalists. A special wireless service to it will be sent from Britain and the United States giving the latest news.

**A Large Wash.**—There is a laundry in Southampton, England, which has few customers but a large wash, turning out 6,500,000 pieces for the "Majestic," "Olympic" and "Homer." The same vessels require annually 50,000 gallons of liquid soap, 170,000 pounds of soft soap, 63,000 pounds of soap powder, and 45,000 pounds of soda to keep everything "ship-shape"; 35,000 sponges and floorcloths perish in the using each year. While there may be little dust at sea there must be considerable in port for over 20,000 brooms and brushes are used up each year. The metal work is not neglected, about 15,000 tins of polish being consumed each twelve months.

## The supply of shovel labor is becoming smaller and dearer



A California salt plant (airplane view) and a New England power plant using Barber-Greene.

## How machine shoveling and conveying reduce the need for alien labor

The growing frequency of wage increases for shovel labor seems to be due principally to the effect of the Dillingham immigration law and the generally increased industrial activity.

It has long been a common statement that "we are absolutely dependent on alien labor to use the shovel," and common knowledge that for a large part of 1922 the emigration of such labor exceeded the immigration.

The natural recourse is the employment of mechanical shovelers and portable conveyors in handling materials.

Users of Barber-Greene Bucket-Loaders (mechanical shovelers) and Barber-Greene Conveyors report that this equipment greatly diminishes the cost of handling materials and in addition the troubles and expense of employing "floating gangs."

A Massachusetts plant has eliminated an entire coal-handling night shift of 10 men with Barber-Greene equipment.

An Illinois road-builder replaced fourteen men last year with a Barber-Greene stone-loader and ten with a sand-loader. An Ohio contractor replaced a 3/4-yard crane with a Barber-Greene conveyor and found that it unloaded an average of ten cars of slag a day as against four handled by the crane.

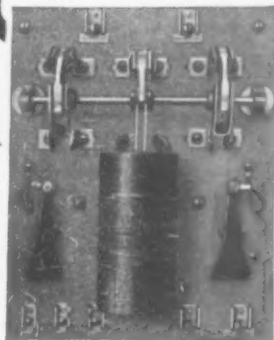
Similar increases in the amount of material handled and decreases in the cost of handling have been recorded in official cost reports covering installations in many states and industries.

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### Miscellaneous Notes

**A Large Order of Postage Stamps.**—The Bureau of Engraving and Printing recently printed 315,265,000 postage stamps in one day. It took 568 mail pouches, three packages to a sack to send them to their ultimate destination.

**Magna Charta Holds Its Own.**—Last year 14,000 persons were made happy by being permitted to see the famous charter of British rights in the British Museum. Heavy green blinds are kept over the precious parchment to exclude the full light rays and thus prevent deterioration, but are lifted to show the charter to admiring pilgrims.

**A "Spoken" Newspaper.**—The *Parole Libre* of Paris is a "spoken" and not a printed newspaper. This is done in the form of semi-weekly lectures to which subscribers and buyers of the daily are invited. At these meetings the current events are read off by the editors, while prominent persons are called in to discuss important events, this being a substitute for editorials. The price of admittance has been fixed at two francs.

**Henna Baths.**—Some of the ultra-fashionable women of London seem to consider an olive colored skin desirable and are getting it by Henna baths. The craze is said to be of French or American origin. Baths, strongly tinted with henna dye, are taken monthly and impart a delicate tint which looks well with the evening dresses of Oriental shades and design now popular here. The immersion method is declared to be easier than that of treating only that considerable portion of the body exposed by modern evening gowns.

**Canada's Mineral Output.**—Mineral production in Canada in 1922 is estimated to be worth \$180,622,000, an increase of about \$6,000,000 over the production of the previous year, says a preliminary report of the Bureau of Statistics. The value of the metals produced was \$61,731,000, as compared with \$49,343,232 in the preceding year; fuels and other non-metallies dropped \$4,000,000, to a total of \$83,891,000, and the production of structural materials and clay products has been estimated at the same valuation as last year, namely, \$35,000,000.

**675 United States Firms Have Factories in Canada.**—Branch works of United States firms in Canada are reliably estimated at 675, of which Ontario has 335, according to the Board of Trade *Journal and Commercial Gazette* of London. There are 185 such industries in Toronto and 75 in Hamilton. Among the United States industries that have recently established in Ontario are carpet sweepers, abrasives, snap fasteners, brushes, steel springs and window glass. Cheap electric power and a fairly well-supplied and contented labor market have been contributing factors in attracting these firms here.

**The Passion Play Seen by 318,040 Visitors.**—The Passion Play of Oberammergau had 318,040 visitors and the players received on the average \$2.25 for all of the 66 performances at the prevailing low rate of exchange. The United States contributed 22,231 visitors, while the United Kingdom provided only 12,263 visitors. The Passion Play has real scientific interest as it shows the survival of certain characters for generations. There are 1000 in the cast of whom 124 speak or sing; 21,640,470 marks were paid for admission. The writer has seen the Passion Play and can vouch for the wonderful scenic effects which are, of course, produced in broad daylight as the play takes all day and is performed in the open air.

**Electric Furnaces in the Brass Industry.**—As the result of a study of brass-furnace practice in the United States, the Bureau of Mines declares that the complete substitution of electric furnaces for the crucible and oil-fired types should result in savings in the brass-melting industry amounting to two or three million dollars a year. The bureau estimates that, if all brass made in the country could have been melted electrically in 1917 and 1918, the war expenses of the country would have been reduced some twenty million dollars. The manufacture of brass in the old style types of furnace has been characterized by enormous losses of zinc through vaporization, possibly as much as 6 per cent of the metal present having been lost in making brass castings and 10 per cent in making wrought brass. It has been estimated that 7500 pounds of zinc passed into the atmosphere daily in the form of zinc oxides from the stacks of the brass-casting shops of Waterbury, Conn., alone.



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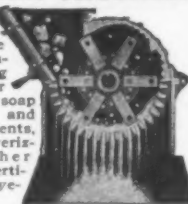
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This illustration of a special use is merely representative of the breadth of magnetic separation. Wherever crushing or pulverizing machinery is used—in mines, mills, smelters, fertilizer plants—it prevents crusher breakdown and plant shutdown by removing tramp iron from conveyed material. It is used for the refining and separating of iron, gold, copper, zinc, and other metals; for removing iron in the manufacture of glass, pottery, and other products where iron is injurious; for preventing grain dust explosions in milling plants by removing the iron before the grain reaches the grinders; for reclaiming iron from cupola slag and refuse in iron foundries and for separating iron from non-ferrous metals in non-ferrous foundries.

Somewhere in the wide range of uses to which magnetic separation can be put, listed below in part, there may be a solution to some of your problems. Consult specialists.

Magnetic separation is used in mines and smelters, in abrasive manufacturing and reclaiming plants, in foundries, smelting and refining plants, ore testing laboratories, grain elevators, tanneries, for rubber and garbage reclaiming and in the manufacture of fertilizers and glues, drugs and chemicals, charcoal, potteries and china, cattle and poultry foods, flour, distillery and brewery products, chert, crucible clay, cement and gypsum, talc, glass, carbon and batteries, ammunition, celluloid, paper and pulp, gas mantles, beet and cane sugar, chocolate and cocoa, vegetable oil and for many miscellaneous operations.

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### Electrical Notes

**Residential Meters.**—Consumption of watt-hour meters of the house type is conservatively estimated at 1,750,000 for the year 1922, according to *Electrical World*. Manufacturers have reported that production of this article is well over the 1,900,000 mark. The associated activity of meter protective and safety equipment also had a remarkable development.

**Storage Battery Production** showed an enormous gain during the year 1922, due to the radio demand for storage batteries as well as the usual automobile demand. The gain is estimated at 25,000,000 batteries. However, it is doubtful if the 1923 production will come up to 1922. Although the automobile demand will be great, the radio demand is certain to fall off to a large extent. The introduction of the single dry-cell vacuum tubes has made it unnecessary to use storage batteries in radio reception, and as a consequence amateurs are turning to dry batteries instead of storage batteries.

**A New Flat Armored Cable** has been introduced on the market. It is especially intended for the wiring of hollow-tile brick and concrete houses. It can be laid directly on the surface of the tile, brick, or concrete walls, without cutting or grooving, and covered with the usual thickness of plaster. Thus outlets can be readily located on the outside walls as well as inside partitions. And for concealed extensions in office buildings, a narrow groove cut in the plaster is all that is needed. Besides, the extreme flexibility and flat shape of the oval-shaped flat armored cable makes it particularly attractive for exposed surface wiring.

**Carrier-Current Telephony.**—By combining the general principles of radio to high-tension electric wires it becomes possible to transmit telephone messages between various points along a transmission line. One electric company in New York State is now transmitting telephone messages over a distance of 12½ miles of 44,000-volt transmission line, with good results. The operation of the carrier-current telephone sets is said to be almost as simple as with the ordinary telephone. Taking the receiver off the hook starts the motor-generator set and puts the apparatus into condition for either talking or receiving. There is a small key, similar to the key on a telephone switchboard, mounted on the telephone stand. When the key is pushed up a calling signal is sent to the other station. The key is then released, leaving the telephone in condition for receiving. When the operator desires to talk he pushes the key to the talking position then releases it for listening. It is said that there is no noise discernible from the regular power current in the transmission lines, and there has been no interference from any radio signals. The same electric company contemplates an additional carrier-current set of 250-watt capacity which will be employed over a 66,000-volt transmission line for a distance of approximately 60 miles, then over a lower-voltage line for a distance of approximately 30 miles.

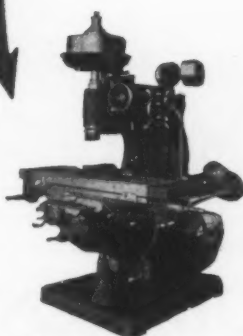
**Tricks of the Current Theft.**—There are electric current consumers who believe it to be an unpardonable fault to pay for the current which they consume. To the end of evading the electric light bill in whole or in part, they resort to all kinds of trickery. The most common trick is to tamper with the meter—a dangerous practice, but one which is often resorted to by current thieves. Perhaps the most ingenious trick of this nature is to introduce the lowly cockroach into the meter case. The cockroach, upon finding the meter to be quite comfortable quarters, proceeds to invite other cockroaches and pretty soon the meter is converted into a domicile housing many cockroaches. In due course the works, especially the aluminum damping disk of the meter, become clogged and the meter no longer functions, although current continues to flow through to the consumer. Trick wiring is also resorted to. In the case of a large public market in New York City, it was discovered following a serious fire which all but destroyed the building, that trick wiring had been installed under the floors so as to by-pass current around the meter. The electric light company through threat of suit collected a sum of money running well up in the five figures from the public market officials. The electric companies have special men—electrical detectives, so to speak—whose task is to run down current thieves. And they are kept quite busy at all times.



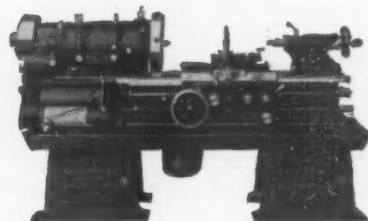
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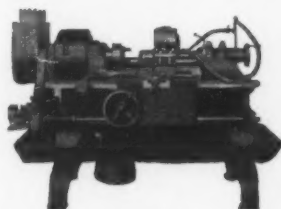
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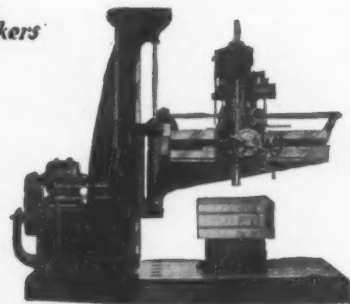
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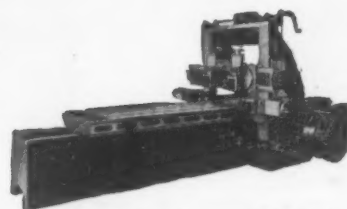
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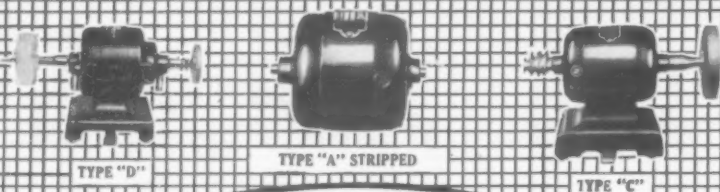
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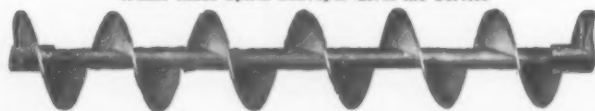
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**The Magnetic Clutch** is coming more and more into favor as its numerous advantages are being realized. One well-known type of magnetic clutch consists of but two parts, one which carries the magnetic coil, and the other an iron disk. There are no toggles, links and other parts to get out of order. The engagement and the disengagement are thus easily controlled by simply pushing a button or operating a small switch. The clutch requires but small space and operates successfully at high or low speeds. It does not grab the load, but rather it has a smooth accelerating action. The period of energizing is sufficient to cushion the force of engagement. Many new ways of effecting savings through the application of the easily-controlled, rugged magnetic clutches are being discovered by engineers and industrial heads.

**An Electric Dictaphone.**—In a recent issue of *Elektrotechnische Zeitschrift* there appears a description of a novel type of dictating machine. Instead of the usual mica diaphragm which is set in motion by the impact of the sound waves, this German dictaphone makes use of a special form of telephone receiver the diaphragm of which operates a steel stylus that cuts into the soft wax of the cylindrical record. Powerful magnets in the receiver, in co-operation with the speech-amplifying vacuum tube mounted within the apparatus, guarantee a reliable and permanently adjusted recorder. The machine is said to be fully automatic and all the operations are controlled by push-buttons. Owing to its electrical features it may be employed for the recording of telephone messages. One machine may be used by several persons in various parts of an office, one at a time, by means of a simple wiring system.

**A Time Switch for the Poultryman.**—It has long been the consensus of opinion among poultry authorities and the U. S. Department of Agriculture that artificial early morning lighting of the henry will materially increase the winter-egg production of pullets and individual hens. Electric lights advance the season of heavy egg production from the spring months, when days are longer, to the shorter days of fall and winter, and do not harmfully force production, so it is claimed. Also, hens under light are in better physical condition and more resistant to disease. The best time to start the lights is 4:00 a. m. With these arguments in mind, an electrical manufacturer has introduced a time switch especially designed for turning on lights in the henry. The only lighting equipment necessary in the hen house is two 25-watt lamps or one 50-watt lamp to 20-foot square of floor space, together with a reliable time switch.

**Diesel-Electric Railroad Cars.**—While German designers of Diesel-driven railroad cars have reverted to earlier types with gear shift and friction clutch, Swedish engineers have continued to develop the Diesel-electric car, with electric transmission from Diesel motor to driving wheels. This type of automotive car, according to *Electrical World*, has given very good service, and there are indications that by its aid the difficult problem will be solved by keeping up in an economical way frequent passenger accommodations on roads in outlying districts. Besides two earlier Diesel-electric cars of limited capacity, two new types have been developed, one weighing 37 tons, with a 160-horsepower engine, the other a 50-ton car, with a 12-cylinder, 250-horsepower Diesel engine. Two cars of the 37-ton type which have been hauling 80-ton trains during six months of the year 1921 gave an average oil-fuel consumption of 0.45 kg. to 0.61 kg. per train-kilometer, the higher figure applying to a road with numerous heavy grades.

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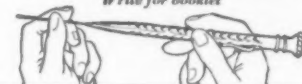


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### Travel and Exploration Notes

**A Lost Outpost of Civilization.**—On the banks of the upper Parana River, which separates Paraguay from Argentina, is a town called Posadas. "This," says a traveler, "is the lost outpost of civilization on the Alto Parana, face to face with the primitive forest, wild Indians, the unexplored center of South America, and yet it is reached by a broad gage railroad, has a fine modern \$500,000 hotel, three big department stores and the best hospital in northern Argentina."

**A School of Medicine on the Mount of Olives.**—Three New York physicians, acting in behalf of the American Jewish Physicians' Committee, have established a medical college in Jerusalem as part of the Hebrew University there. The physicians returned recently from a month's stay in Palestine, where they purchased a site on the Mount of Olives. Plans for erecting the first set of permanent buildings have been completed. Actual work will begin as soon as the rainy season is over. Already a building has been rented as temporary quarters for a school for research in tropical diseases.

**Three Kilimanjaro Peaks Joined.**—George Gillman read a paper before the Geographical Society descriptive of an ascent a year ago of Kilimanjaro, which he alluded to as Africa's highest mountain. The party which he led were the first to ascend after the mountain had become British territory. From wherever across the surrounding steppes one approached the isolated mountain mass two outstanding features impressed themselves at once—the tremendous size, coupled with great height, and the almost incredible contrast between the tropical half desert below and the alpine desert above. Structurally, Kilimanjaro consisted of three single strato-volcanoes, each of which had had its own origin and history. Through mutual interbedding of the lava flows, however, all three had grown into one solid complex strato-volcano.

**The Geology of the Mount Everest District.**—The Mount Everest expedition of 1921 included among its staff Dr. A. M. Heron, who contributes to the *Geographical Journal* an account of his geological investigations, accompanied by a geological map. Dr. Heron's task was one of unusual difficulty. Over much of the area examined his work had to proceed in advance of surveys, while the movements of the expedition were generally unfavorable to detailed work. Close and prolonged examination, moreover, was considered inadvisable, since it aroused the suspicions of the Tibetans. Dr. Heron claims that his work must be looked on only as a reconnaissance. The area examined covers more than 8000 square miles, and consists in the main of the Tibetan portion of the drainage area of the Arun River above Kharta. Two geological divisions can be recognized: a Tibetan area of sedimentary rocks which consists chiefly of east and west folds of Jurassic slates, and the crystalline Himalayan region to the south. The contrasts in topography clearly illustrate the differences in the underlying structure. On one hand are the somewhat tame rounded ranges, with broad valleys, of Tibet, and on the other the high, steep, and rugged Himalayas.

**Mount Everest on the Screen.**—The films which were taken by the Mount Everest Expedition are being shown in London and will undoubtedly come to this country soon. The proceeds will go to the equipping of a third expedition. The first part shows the country through which the expedition passed on its way to Mount Everest. The second section deals with monastic life in Tibet and records the curious ritual dances which the party was so fortunate as to see at the Rongbuk monastery at the very foot of Mount Everest. The dances are performed by lamas, attired in fantastic costumes and wearing huge masks, who represent the good and bad spirits the devout will meet in the next world; devil dances, dances in which ghouls carry a small dummy representing a dead body, and a procession of the gods are among the scenes depicted. The third section of the film shows the actual assault on Mount Everest. Scene after scene of indescribable grandeur is shown. Many portions of the film, such as those showing the final attempts on the summit from the highest camp, at about 25,000 feet, were taken with a telephoto lens. The music played in the interval and during the exhibition of the film is based on Nepalese and Tibetan airs and pastoral music, and some of the tunes provide very beautiful though simple subjects.



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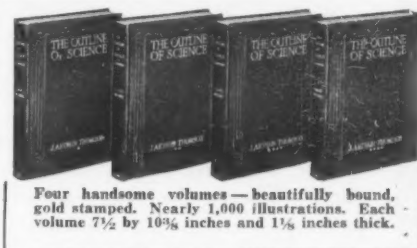
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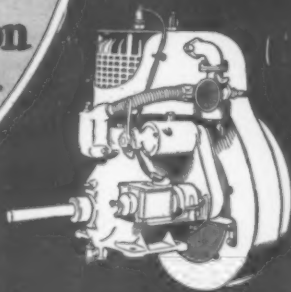
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## Archaeological Notes

**A Carthaginian Galley Discovered.**—A submerged Carthaginian Galley has been discovered about 60 miles from the site of the old Phoenician seaport. It is believed to contain statues stolen from old Greek cities.

**Egyptian Surgery.**—A papyrus now being translated in Chicago indicates that the early Egyptians were familiar with trephining the skull, draining of jaw-ulcers and the setting of fractures. It will be a long time before the whole manuscript has been deciphered.

**The Date of Stonehenge.**—Astronomers are still trying to determine the date of Stonehenge. It is probable that 1840 B. C. is an approximation. The error plus or minus might be 200 years so that the actual date is probably not earlier than 2040 B. C., or later than 1640 B. C.

**A Mexican Prehistoric City.**—A prehistoric city has recently been discovered at the foot of the volcano Ixtaccihuatl. The city is apparently four miles long and three miles wide. The city is surrounded by a wall and there are twenty-eight pyramids. There is a possibility of the ruins being as famous as Teotihuacan.

**Stone Age Village Unearthed in Surrey.**—The remains of an early village believed to be of the stone age has been recently unearthed in Surrey, England. Pottery seems to have been the principal industry carried on there. The soil is sandy, which has tended to keep the remains in a good state of preservation.

**Plato's Alarm Clock.**—H. Diels, following a suggestion derived from the musician, Aristocles, as quoted by Athenaeus, has presented a new reconstruction of the alarm devised by Plato to wake the students of the Academy. A quantity of water suddenly released from an upper receptacle fills a lower, forcing the air in the latter through a pipe and so producing a sound which was an ancient anticipation of the modern factory whistle.

**Excavations at Doura.**—A new employment has been found for France's foreign legion in time of peace. In the last few months they have been excavating along the Syrian and Mesopotamian frontiers and have uncovered the ancient city of Doura, whose temples have revealed many archaeological treasures. Stone tablets with Greek and Latin inscriptions, giving the history of the city, as well as the ruins of a Roman amphitheater with elaborate frescoes were found.

**Discovery of a Roman Theater.**—Excavations at the ancient Civita Lavinia on the border of the Pontine Marshes, have brought to light the remains of an exquisite Roman theater. This was the Lanuviana of classical times. On the ancient walls of the town may be seen the massive iron rings where legend says, Aeneas tied his ship when he landed in Italy from Troy. The theater is one of the largest and most perfect hitherto found. Its diameter is more than 160 feet, being only a few feet short of the theater at Pompeii.

**The Indignities of Tutankhamen.**—Not satisfied with making a show place of the site of the tomb, as they will later of the tomb itself, the natives of Luxor are clamoring against any removal of the mummy of Tutankhamen, when it is found. X-ray pictures will also be taken before any attempt is made to unroll the cerements of the tomb. Probably a film will also be made as the bandages are unwound. The poor king has been advertised as no other has ever been except perhaps Julius Caesar and Napoleon.

**The Great Monoliths of Tinian.**—Although the existence of the colossal columned tombs of Tinian, an island of the Marianne group, north of Guam in the Pacific Ocean, has been known ever since 1746, says the *Christian Science Monitor*, when Lord George Anson, an English naval officer, described them, no effort was ever made accurately to measure, excavate and photograph them until a few months ago. The pillars are monoliths of hard island rock 15 feet high, 5 feet 4 inches square at the base and weighing over 30 tons, being surmounted by a hemispherical top piece weighing more than seven tons. The pillars are arranged in two parallel rows, five in a row, and study of these sites indicates that they were monumental religious structures. Something of the significance of the size of the blocks may be gained by realizing that the Tinian stones are heavier by five tons than the largest of any of the single blocks used in the Egyptian pyramids.

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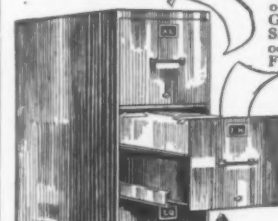
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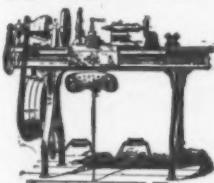
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**Archaeological Notes**

**A Third-Century Birmingham.**—Preliminary excavations have just been completed on the site of what the London *Times* calls "a third-century Birmingham," Ariconium, in the Wye valley between Monmouth and Gloucester, near Weston-under-Penyard, three miles from Ross. Over an area of more than 100 acres the earth is full of smelting refuse; evidently a great iron industry flourished there, the iron ore being brought from the Forest of Dean. The only classical reference to the place is in the Itinerary of Antonius, compiled about 150 A. D., and in the fourteenth century the Benedictine monk, Richard of Cirencester, refers to it. Some buildings have been found, the walls of which were decorated in column. A large quantity of pottery, fragments of Samian ware, and a coin of Domitian dated 87 A. D. were also discovered. Ariconium seems to have arisen as a halting place on the Roman road from Caerleon to Silchester in the first century, and it became a busy industrial town in the third.

**Child Sacrifice at Carthage.**—Historical evidence goes to show that the sacrifice of children to the Mother Goddess was not infrequent. Two French archaeologists, Mm. Pouissot and Lautier, engaged in exploring the ruins of ancient Carthage, have unearthed in front of an altar near a temple of Tanit three vaults containing the charred bones of new-born babies and children from two to three years of age. The archaeologists believe that to the left of the altar was a stone slab with a bronze grill, under which burnt a fierce fire, and here the naked bodies of the first-born were offered in accordance with the ancient rites which were regularly practised from the sixth or seventh centuries before the Christian era until the destruction of Carthage by the Romans. Others, however, believe that it was customary for the parents to reclaim the remains of sacrificed children, and that the bones now found, a gruesome pile 15 feet high, are the remains of sacrificed children placed by their parents under the protection of the all-powerful Tanit.

**Rhodian Antiquities.**—The restoration of the Hospital of the Knights in Rhodes has been completed by the Italian authorities with their usual thoroughness and good taste. The medieval hospital of the Knights of St. John is an important link between classical, Byzantine and Turkish periods. The chief ward of the hospital is 190 feet long and 45 feet wide. In the time of the knights this ward contained 100 beds for pilgrims and patients. In 1523 the Turks took Rhodes, and the hospital was diverted to other uses. The Island of Rhodes is in the Aegean and was famous for having one of the "Seven Wonders of the World"—namely, the "Colossus of Rhodes," which was overthrown by an earthquake. The island was the last outpost of the Crusaders. The occupation by the Knights of St. John of Jerusalem dates from the years 1308-1310. The principal aim of this order was the protection of pilgrims and care of the sick. Italy is to retain Rhodes for fifteen years, when a plebiscite of the population, which is mainly Greek, will be taken. The Italians are such colonizers, however, that there is little doubt that the inhabitants will elect to stay under Italian rule.

**"Pipe Shrine House."**—Dr. J. Walter Fewkes reports the finding of an interesting prehistoric ruin which he has named "Pipe Shrine House." This was found in the Mesa Verde National Park of Colorado. A mound was investigated and disclosed a circular tower on a rectangular building about 70 feet square. The tower was probably used for observing the sun as it rises in the east or sets in the west, in order to determine the time for planting and other events. In the middle of the building was found a circular room 20 feet deep and about the same in diameter in which were more than a dozen clay tobacco pipes, numerous stone knives, pottery, idols, and other objects. Pipes of this kind have never before been found on the Mesa Verde National Park; apparently after the rite of smoking they were thrown into the shrine. South of the building, which was evidently specialized for ceremonials, is a square room or shrine dedicated to the mountain lion, a stone image of which was found surrounded by waterworn and other strangely formed stones. A similar shrine in the northeast corner of Pipe Shrine House contains a small iron meteorite and a slab of stone on which is depicted the symbol of the sun.



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### Mechanical Engineering Notes

**Stainless Steel for Machinists' Rules** has now made its appearance with the introduction of a well-known make of six-inch rule, pocket size, of stainless steel. Other stainless steel measuring devices are bound to follow, because they are rust-proof, will not stain or discolor, and always retain their bright finish and clean-cut graduations.

**A Well-Known Type of Pressure Lubricating System** which has proved highly popular for chassis lubrication on automobiles, is now being introduced in various kinds of machinery. This high-pressure lubrication makes use of fittings in place of the usual grease cups, and a force pump or compressor fitted with a flexible hose and a special coupling to engage with the fittings. The coupler is engaged with the fitting, and the compressor is given a few turns of the handle. As a result, the clean lubricant is forced into the bearing to be lubricated under 500-pound pressure, thus cleaning the bearing and forcing out the old lubricant at one stroke, and furnishing clean lubricant. This method of lubrication is claimed to be the most thorough method of lubricating shafting, conveyors, presses, lathes, cranes and many other types of machinery.

**Compressed-Air Tools** of all kinds, especially for outdoor work, are steadily gaining in popularity. Among the recent compressed-air tools which have made their appearance are the paving breakers, designed specifically for cutting asphalt and breaking up concrete pavements. Their application has been extended to include tearing out concrete and masonry foundations and walls, removing slag from reverberatory furnaces, dismantling concrete ships, taking up concrete floors and various other types of demolition work. A recent comparison between compressed-air paving breakers and laborers shows that when working with labor gangs of three or four men using hand hammer and chisel methods, each man averages five cubic feet per hour. The compressed-air paving breaker, on the other hand, averages 23.16 cubic feet per hour per machine.

**Duralumin**, an alloy produced after years of systematic endeavor to meet the demand for a metal which shall be as light as aluminum and as strong as mild steel, yet without the many disadvantages of aluminum in its pure state, is becoming more and more popular with machinists. It is the only light metal that can replace steel in forgings. With a two-thirds saving in weight, heat-treated duralumin forgings approximate mild steel forgings in strength. Wherever weight is a deciding factor, this alloy is the most satisfactory metal for most articles made by hot working or forging. Naturally, duralumin forgings are especially desirable for reciprocating or moving parts where inertia, due to their own weight, forms a large part of the total stress. A few advantages of duralumin are that it machines better than aluminum and at a cost greatly reduced when compared with iron or steel. It taps and threads well. When used for reciprocating parts the weight is reduced without loss of strength, acceleration is increased, and weight is decreased. It polishes easily, resists atmospheric conditions, and no plating is required. It can be rolled, forged, drawn, heat treated, and annealed. It is worked either hot or cold.

**Hack Saw Blades.**—Next to the composition of the steel from which it is made, the most important factor in the efficiency of a hack saw is the shape of the teeth, according to a leading authority. Teeth milled perfectly straight on the face and cut to a depth of little less than the distance between two teeth give the most serviceable and fastest cutting blade. The slope of the front and the back face of the tooth has a decided effect on the active life of the blade. The proper pitch of the teeth is determined by the power which may be applied, as well as by the hardness, texture and shape of the material to be cut. Different metals and shapes require different blades for the most efficient cutting. Hence it is impossible to lay down any arbitrary rule that will fit all conditions. The best and safest practice is to follow the recommendations of the manufacturer. Broadly speaking, the length of a blade should be in proportion to the size of the stock to be cut, though the shorter the blade the greater the pressure it will withstand. Avoid freak blades. Those who have used hack saws over a period of years know that the standard blade made by a reputable company gives the best results.

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### Aeronautical Notes

**A Gliding Record** was recently made by Lieut. Thoret, a French military aviator, when he kept in the air for seven hours and three minutes at Biskra, Algeria. The feat was accomplished in a regulation army airplane, a Hanriot biplane with 80-horsepower Le Rhone engine, and with the propeller previously wedged to prevent its operation. In addition to its motor, gasoline, and oil supplies, the machine carried an extra weight of 500 pounds. It was in no way modified for gliding. Lieut. Thoret's flight has broken all records for gliding by a good margin.

**Helium Statistics.**—Official statements in connection with the Bureau of Mines reinforce the view that helium gas is beyond reach for the inflation of non-inflammable passenger airships. Four years' work by several official plants in the United States have produced 2,400,000 cubic feet of gas, which is the amount required (including reserve supply) for one big airship. The cost remains prohibitive, for the lowest figure hoped for in the near future is 10 cents per cubic foot, and the hazy expectation that ultimately the cost will be reduced to 2 or 3 cents per cubic foot does not alter the facts.

**Helicopter Records.**—Just as the airplane in its early days performed better and better as months went by, the helicopter, now in its very infancy, is steadily improving. Recently a helicopter built by a Spanish engineer, Juan la Cierva, successfully rose to a height of 81 feet and carried out several horizontal flights. On one occasion the machine flew beyond the limits of the Getafe airdrome where the trials took place. The helicopter is supported by a four-bladed screw and carries an 80-horsepower engine. It now appears that the unofficial records for free helicopters stand as follows: Duration: Oehmichen helicopter, 2 minutes, 37 seconds, France. Distance: Oehmichen helicopter, 250 feet, France. Altitude: La Cierva helicopter, 81 feet, Spain.

**Radio on Civil Aircraft.**—Six flying boats and one land airplane have recently been licensed by the Department of Commerce to carry radio on board, according to Aviation. These are the first American civil aircraft so equipped, Army and Navy aircraft have for some time past been fitted with radio apparatus, but Government machines need not be licensed, whereas civil aircraft do. The first American civil aircraft to be licensed as a "limited commercial station" was one belonging to the Airline Transportation Company of California. The Aeromarine Airways followed with the "Buckeye" in December, and licensed five more recently. Radio equipment, officials believe, will make for greater safety in overseas travel and insure prompt aid should the craft be forced down.

**Aerial Camera in Everyday Life.**—The aerial camera is taking an economical and highly important part in the reconstruction of the devastated areas of France, and in the restoration of the arid regions of Egypt and Mesopotamia, which in ancient times were the centers of civilization," so states Sherman M. Fairchild, an authority on aerial photography, who recently returned from abroad. Mr. Fairchild, it will be recalled, wrote a most complete article on aerial photography and its applications, which appeared in our columns some time ago. "Shortly after the Versailles Treaty was signed," continues Mr. Fairchild, "a French law was passed requiring every city in the republic, above a certain size, to be resurveyed within three years. It would have been physically impossible and financially impracticable to accomplish this by ground methods. The result was that mapping by air was adopted throughout, and one company alone surveyed 200 cities from airplanes. Aerial mapping is being extensively used by the ministry of liberated regions. The areas of France devastated during the war are being resurveyed from the air, as in many cases not only were property lines obliterated, but the records of entire communities destroyed. The City of Paris was mapped from the air to a scale of 200 feet to the inch, thus making it possible to identify even small buildings. Corrections such as new structures, streets, etc., were printed in red over existing maps. For this air mapping work the French company received the equivalent of \$400,000." Mr. Fairchild believes that a rich field for development in aerial photography awaits American companies entering Central and South America, and such European countries as Spain, Greece, etc.

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A fixed condenser must be constructed. This consists of nothing more formidable than a number of sheets of tin foil separated by pieces of paraffined paper. A good condenser may be made by cutting six pieces of tin foil one inch wide by three inches long and cutting eleven pieces of paraffined paper so that they will measure one inch wide by two inches long and one-quarter inch thick. The paraffined paper and the tin foil sheets are assembled in staggered order as shown in the accompanying sketch. The pile of tin-foil and paraffined paper can be placed between two pieces of cardboard and held together by means of a rubber band or piece of thread wrapped around the cardboard end pieces.

The grid leak had best be purchased, for it is a rather complicated variometer, showing the variable and partly turned. The fixed and the movable windings are wound in series, so that the current must pass through both of them, and

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case as to operate an armature which connects with a mica diaphragm. The slightest current variations throughout

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## Radio Notes

A Review and Commentary on the Progress in This Branch of Rapid Communication

The New Radio Station at Shabolevka, in Moscow, was able to receive messages from the recent conference at Genoa. Messages are sent by the commissariat for foreign affairs through this station. The receiving department is equipped with three apparatus, all of Russian construction. The station has two masts, each 560 feet high.

The Canadian Government is planning a chain of radio stations extending right into the Arctic Circle, which are now being completed. Six stations are planned, five of which will be in the northwest territories and another at Dawson. The stations on or near the Mackenzie River will be located at Fort Smith, Fort Resolution, Fort Simpson, Fort Norman, and Fort McPherson.

Our Tubes and European Tubes.—While it is true that American-made vacuum tubes are expensive, as compared with European tubes, the fact remains that our tubes are far more desirable than the usual run of European tubes. Our tubes have better and neater construction and they run more uniform as regards performance. In fact, for a given degree of amplification, it will be found that less American tubes will be required to do the same work than if European tubes were used.

Broadcasting in Ireland.—A radio station, somewhat similar to the Eiffel Tower in Paris, but not quite so large, will shortly be erected in Dublin, according to the British press. It will be entirely a Government enterprise, and is expected to be situated in the Phoenix Park, where there is every facility for such a plant. The Free State authorities, once the station is established, intend broadcasting to towns in the provinces the latest market reports, news, weather bulletins, and so on, which would be of use to the community and would assist trade.

St. Elmo's Fire.—The well-known phenomenon, St. Elmo's fire, which is a form of atmospheric electrical discharge, was recently observed aboard a steamer. During heavy rain squalls accompanied by heat lightning, the port wire of the radio aerial aboard a steamer became illuminated for its entire length with a glowing white light, giving the wire a fuzzy appearance. This continued for about 10 minutes, after which the light gradually faded from the ends of the wire and finally disappeared from the center of the aerial. The compasses were not affected.

Number of Radio Stations.—According to the number of licenses issued by the Department of Commerce, there were 544 class A radio telephone broadcasting stations and 25 class B stations on January 1, 1923. Of amateur stations, there were 16,898, as compared with 1312 in 1913. Special amateur stations numbered 201; experimental stations, 291; technical and training schools, 126; inter-city stations for commercial traffic, 167; coast stations for communicating with ships, 39; trans-oceanic, 12; and ship stations, 2762. In all, there were 21,065 stations on January 1 last, as compared with 1890 in 1913.

The New York Station WNY of the Radio Corporation is using as far as practicable, interrupted continuous waves and continuous waves for communicating with ships, in order to reduce the interference in that territory. All vessels calling this station and capable of receiving CW signals on 600 meters should indicate that they will stand by for the acknowledgment of their call on 600 meters CW by transmitting after their call letters, "Ans 600 CW" and should adjust their receiver accordingly. All vessels not equipped with CW receivers should tune carefully on 600 meters ICW, which will be used unless CW is requested.

Audio-Frequency Transformers.—Little does the average radio novice realize the elaborate workmanship which enters into the usual audio-frequency transformer. Indeed, the low price of such devices tends to conceal the elaborateness of these devices, but the low price is due solely to a cut-throat competition which brings down selling prices irrespective of quality and cost of manufacture. Thus one of the best known transformers on the market has 3800 turns

of No. 40 enameled wire for the primary winding. Glassine paper is used between layers, and a one-eighth inch paper projection on each end serves for mechanical protection. The secondary winding is separated from the primary winding by three thicknesses of .005 inch moleskin paper, and has 13,300 turns of No. 40 enameled wire with the same insulation and end protection. The primary and the secondary leads are 16 strands of No. 38 bare copper wire stranded together and covered with one wrapping of green silk. The coil is impregnated under vacuum process in a compound consisting of beeswax and rosin, and is covered with black pebbled bookbinder's cloth.

Recording High-Speed Signals.—The results of research by the research department of the Radio Corporation of America are given in the *Proceedings of the Institute of Radio Engineers*. The requirements of high-speed recording apparatus are first discussed, and the relative merits of various types of recording equipment are then dealt with. A new form of recorder, called the "ink recorder," is next described. The essential parts of the recording system are as follows: A small circular coil is placed in the radial field produced by a powerful solenoid type of electromagnet, and a link rising from the coil frame engages the pen arm. The latter is supported at one end by a thin, wide steel spring, and carries at its other end a short piece of metal tubing about half an inch long, called the pen. The pen takes ink from a device called the "ink feed" at one end and writes on the paper tape at the other. If the magnet is energized and signal current passes through the small coil, it is pulled upward. The link, therefore, pushes the pen arm up; the pen moves upward in the bead of ink on the face of the ink-feed nozzle, supplying itself with ink by capillary action as it goes, and makes a vertical line on the slowly moving tape. When the signal stops the spring sends the coil back to its starting position. Speeds up to 100 words per minute have been handled with this recorder, and, with certain changes in the pen-arm spring, 200 words per minute.

Electrons from Hot Filaments.—When metals are heated in high vacuum, electrons, or atoms of negative electricity, evaporate from their surfaces. If there is another electrode in the evacuated space to which a positive charge is given the electrons drift over to this electrode (anode) so that a current flows between the two electrodes. The electron emissions from a large number of different materials have recently been measured, according to *Electrical World*. The thoriated tungsten cathode gives a current at a temperature of 1500 degrees absolute which is about 130,000 times greater than that secured from ordinary tungsten. Some of the cathode materials have even much greater emissions. In order to get all the current that a cathode is capable of giving, it is necessary to apply to the anode a high enough voltage to overcome what is known as the space charge effect. By putting gases inside the tubes positive ions are formed in the space between the electrodes by bombardment, and these neutralize the negative space charge and allow the current from the cathode to pass across the space with much lower anode voltages. The effect of gases, therefore, is to increase the current-carrying capacity of the tube. The thoriated tungsten filament is a tungsten filament containing 1 per cent or 2 per cent of thorium, usually in the form of an oxide. When such a filament is heated to about 3500 degrees Centigrade, a little of the thorium oxide is changed into metallic thorium. In the meantime, however, any thorium on the surface of the filament evaporates, leaving only pure tungsten. If the filament is then lowered to about 1800 degrees, the thorium gradually wanders or diffuses through the filament, and when it reaches the surface, if the vacuum is quite perfect, remains there and gradually forms a layer of thorium atoms which never exceeds a single atom in thickness. The thickness of this film is therefore about one one-hundred-millionths of an inch, and yet this film increases the electron emission of the filament about 130,000 times.

## Radio Inventions

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### Pompeii Uncovered

(Continued from page 231)

only 18 years of age, records how calm he and his mother were even in the shadow of possible disaster. He says: "Though it was now morning, the light was exceeding faint and languid; the buildings all around us tottered, and though we stood upon open ground, yet, as the place was narrow and confined, there was no remaining there without certain and great danger. We, therefore, resolved to quit the town. Being got at a convenient distance from the houses we stood still in the midst of a most dangerous and dreadful scene. The chariots which we had ordered to be drawn out were so agitated backwards and forwards, though upon the most level ground, that we could not keep them steady even by supporting them with large stones. The sea seemed to roll back upon itself, and be driven from its banks by the convulsive motion of the earth; it is certain at least the shore was considerably enlarged, and several sea animals, were left upon it. On the other side a black and dreadful cloud, bursting with an igneous serpentine vapor, darted out a long train of fire resembling flakes of lightning, but much larger. Soon after the cloud seemed to descend and cover the whole ocean. The ashes now began to fall upon us, though in no great quantity. I turned my head and observed behind us a thick smoke, which came rolling after us like a torrent. I proposed, while we had yet any light, to turn out of the high road lest we should be pressed to death in the dark by the crowd that followed us. We had scarcely stepped out of the path, when darkness overspread us like that of a room when it is shut up and all the lights extinct. Nothing then was to be heard but the shrieks of women, the screams of children, and the cries of men. At length a glimmering light appeared, which we imagined to be rather the forerunner of an approaching burst of flames, as in truth it was, than the return of day. However, the fire fell at a distance from us. Then again we were immersed in thick darkness, and a heavy shower of ashes rained upon us, which we were obliged every now and then to shake off, otherwise we should have been crushed and buried in the heap. At last this dreadful darkness was dissipated by degrees, like a cloud of smoke; the real day returned, and even the sun appeared, though very faintly, and as when an eclipse is coming on. Every object that presented itself to our eyes (which were extremely weakened) seemed changed, being covered over with white ashes, as with a deep snow. We returned to Misenum where we refreshed ourselves as well as we could, and passed an anxious night between hope and fear, for the earthquake still continued. However, my mother and I, notwithstanding the danger we had passed, and that which still threatened us, had no thoughts of leaving the place till we should receive some account from my uncle." Pliny, the elder, was suffocated, being very corpulent and having weak lungs.

We are very fortunate in having the testimony of an eye-witness who, while young, had been trained in observation by his uncle. The two letters were written to Tacitus. They confirm the fact that Pompeii was not destroyed by an inundation of lava; its elevated position sheltered it from that fate; it was buried under that shower of stones and cinders of which Pliny speaks. Much of the matter appears to have been deposited in a liquid state, which is easily explained; for the vast volumes of steam sent up by the volcano descended in torrents of rain, which united with the ashes suspended in the air, or washed them after they had fallen into places where they could not have penetrated in a dry state.

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MANUFACTURERS on large scale and home-workers wanted to manufacture metal toys and novelties. Barking Dogs, Wag Tail Pups, Wild Animals, Automobiles, Indians, Bird Whistles, Cowboys, Baseball Players, Cannons, Toy Soldiers, Statues of Liberty, Miniature Capitols, Bathing Girl Souvenirs and others. Unlimited possibilities. Guaranteed casting forms, complete outfit, furnished manufacturers from \$5.00 up. No experience or tools necessary. Thousands made complete per hour. 1923 business starts now. We buy goods all year and pay high prices for finished goods. Cash on delivery. Contract orders placed with manufacturers. Special casting forms made to order. Catalogue and information free. Correspondence invited only if you mean business. Metal Cast Products Co., 1696 Boston Road, New York.

### AGENTS WANTED

SALESMEN given protected territory to sell Doublewear Shoes direct from factory to wearer. Our new measure board insures perfect fitting. Write for particulars and list of open counties. Doublewear Shoe Co., Manufacturers, 319 E. Lake, Minneapolis, Minn.

LARGE SHIRT MANUFACTURER wants Agents to sell complete line of shirts direct to wearer. Exclusive patterns. Big values. Free samples. Madison Mills, 603 Broadway, New York.

MAKE MONEY silvering mirrors, all kinds plating, knives, spoons, auto headlamps. Outfits furnished; free booklet. International Laboratories, Dept. 305, 311 Fifth Ave., New York.

AGENTS 500 per cent profit. Free samples gold sign letters for store fronts and office windows. Easily applied. Large demand everywhere. Liberal offer to general agents. Metallic Letter Co., 431-X, North Clark, Chicago, U. S. A.

CLARKE made \$18 an hour selling vestpocket windshield cleaner needed by every autoist, motor-man, engineer; one rub keeps glass clear 24 hours; 60,000 sold; amazing proposition free. Security Mfg. Co., Dept. 677, Toledo, Ohio.

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AUTOMOBILE owners, garagemen, mechanics, send today for free copy America's most popular motor magazine. Contains helpful articles on overhauling, repairing, ignition, carburetors, batteries, etc. Automobile Digest, 542 Butler Bldg., Cincinnati.

LET US show you how to save 30 per cent of your Gasoline. Send your name and address, we'll do the rest. Southwestern Research Laboratories, Oklahoma City, U. S. A.

Auto Wheel Repairers! Attention! ASPHALTASBESTUS (patent pending)

Do you want to increase your profit 100 per cent setting rims and repairing auto wheels? For information write J. Olson, 7th St., Lewiston, Ida.

### BOOKS

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SEND for New Illustrated Catalog of Books on Mechanical Subjects FREE. Spon & Chamberlain, 122A Liberty St., New York.

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YOU CAN have a business profession of your own and earn big income in service fees. A new system of foot correction; readily learned by anyone at home in a few weeks. Easy terms for training; openings everywhere with all the trade you can attend to. No capital required or goods to buy; no agency or soliciting. Address: Stephenson Laboratory, 25 Back Bay, Boston, Mass.

RESPONSIBLE corporation wants general sales managers to open branch offices, manage salesmen, \$500 to \$5000 necessary; expenses to Baltimore allowed if you qualify. Address Manager, 603 N. Eutaw Street, Baltimore, Md.

WORLD'S fastest agent's seller, 300% profit. Needed in every home and store. Establish permanent business. Premier Mfg. Co., 821 E. Grand Blvd., Detroit, Mich.

MEN—Will you increase your earnings? Work at home evenings? Then write, enclosing stamped addressed envelope. Normande S., 147 West 23d St., New York.

\$75-\$150 WEEKLY assured if you hustle. Sell attractive gold signs to stores, offices. Unlimited demand. Experience unnecessary. Free samples. Acme Sign Co., 367 West Superior, Chicago.

\$125 to \$2000 is sufficient to establish you in a cash business, no debts. Free information. Dept. 172, Paul Kaye, 149 Broadway, New York.

### FIREPROOF HOMES

HOW to build good, substantial, durable, beautiful warm and fireproof homes at reasonable cost; read our good old popular book on building. Price one dollar. Peter de Linde, Zion, Ill.

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I SELL PATENTS. Established in 1900. To buy or sell write Charles A. Scott, 773SA Garson Avenue, Rochester, New York.

INVENTORS—Send your ideas for manufacturing development in our modern sheet metal and angle iron fabricating plant. Liberal payment for accepted inventions. Kirk & Blum Manufacturing Co., 2849 Spring Grove Ave., Cincinnati, O.

INVENTIONS developed to practical manufacturing basis. Research and model work strictly confidential. Light manufacturing. Reliance, 135 West Broadway, New York.

PATENTS sold, leased, promoted; experienced handling; immediate action. Send copy of patent and receive free, my booklet, "The Business End of a Patent." Address Arthur S. Billings, 401 Dekum Bldg., Portland, Ore.

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\$50 WEEK, evenings, I made it; mail order business. Booklet for stamp tells how. Sample and plan, 25 cents. Free 12 articles worth \$3. Alsicht Scott, Cohoes, N. Y.

### MISCELLANEOUS

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A BETTER JOB, more money, more leisure are yours when you find your true life work. Send ten cents for Vocational Self Analysis Chart, SCS, Vocational Service Bureau, 20 E. Jackson, Chicago.

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100 DIFFERENT FOREIGN STAMPS (from more than 40 different countries, 10c). Nickles, Room 66, 122 Florida Ave., Washington, D. C.

### FOR SALE

BUY this patent for new type of laundry ink and make quick money. Patented process revolutionizes this product. Cheaply made, quickly sold. Unlimited demand, large profits. Write for proof. Dr. Schmidt, Blanton, Fla.

DEVICE to increase speed in tying bundles and for other uses; patented January 30, 1923; No. 1,443,358; well worth investigation; should interest Stamping Companies. Full particulars from Inventor, Martin E. Gerould, 39 Howell Street, Rochester, N. Y.

BASIC PATENTS looking to combine the gasoline motor and the steam engine. Address all communications to Box 146, Scientific American.

PATENT FOR SALE: Practical, efficient attachment for automobiles. Permits running wood saws, mills and other machines. F. D. Freeborn, Knoxville, Pa.

ONE PATENT and several patentable ideas, for cash, terms or royalty. John P. Schoelerman, Monte Vista, Colo.

U. S. AND CANADIAN PATENT RIGHTS on a simple, practical and inexpensive combined water cooler and filter. Harry T. Allen, Guilford, Connecticut.

ONE-HALF Interest in patent No. 1466531; combination pliers and wrench. Edward Brown, 89 North St., Bristol, Conn.

FOR SALE—Patent Animal Trap for 500 dollars; best on the market. John Arneht, 935 C St., S. W., Washington, D. C.

PATENT rights on following inventions: Cotton harvester; rail-tie without bolts; traveling stairway working any angle; water wheel requiring no dam or race. For full particulars address J. E. Watkins, Smithfield, Ky.

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YOUNG MEN and women to learn Morse and Wireless Telegraphy. Railroads and wireless companies in great need of operators. We teach you quickly and procure positions at big salaries. Opportunities for advancement. All expenses low; can earn part. Write today for free catalog. School established 1874. Dodge's Telegraph Institute, Vail Street, Valparaiso, Indiana.

WORK on models, mechanical or electrical devices on contract basis; machine work and stamping at reasonable prices. Williams-Purchase Mfg. Co., 1 Chubb St., Richmond Hill, Long Island.

SONG POEMS wanted by winner in Hearst's \$10,000 contest. Casper Nathan, Dept. G, 929 Garrick Theatre Building, Chicago, Ill.

### WAR RELICS AND WAR PHOTOS

FOR DENS.—Relics collected from Europe's battlefields. Completely illustrated catalog and sample war photographs 20c. Lieut. Walsh, 2117 Regent Place, Brooklyn, N. Y. I also buy War Relics.

cent nicotine yielded a smoke with 0.20 per cent of the alkaloid. Tobacco, smoked in the pipe, containing 2.85 per cent of nicotine, yields a smoke containing 2.20 per cent of nicotine. Porto Rico Shag tobacco, containing 0.33 per cent nicotine, gives a smoke containing 0.25 per cent of nicotine in the pipe.

### Tiny Air Bubbles and Giant Dams

(Continued from page 232)

inch air main leading back to the compressor in the power house the ice on the river was 10 inches thick, and holes had to be cut in the ice to project the pipes into the water beneath the field. Despite the handicap which that ice represented, yet within a period of seven days—the temperature averaging the while below 15 degrees Fahrenheit—the agitation of the water caused by the ascending air bubbles sufficed to melt the ice away from substantially the full width of every gate.

This performance was in excess of expectations and in a measure undesirable, for it produced too wide a zone of clear water, destroyed effective contact between the field and the piers of the dam, and invited a damaging blow from the field if that mass were driven toward the barrier. The discharge tips, with their one-sixteenth-inch outlets, gave trouble because frost was apt to gather in them and clog them and after a couple of weeks' experience the arrangement of the air jets was found to be faulty. The rising streams of bubbles came to the surface a few feet away from the small tubes, and, as a result, ice formed about the pipes. These accumulations became heavy enough to burden the tubes so that they would bend and break as the water level fell during the peak-load operation of the turbines at night. None of these various shortcomings revealed anything radically wrong with the main features of the system; it was necessary only to make the needful corrections.

To this end, the engineers removed the submerged tips of the  $\frac{3}{8}$ -inch tubes so that the escaping air could have an unimpeded vent; the pipes were arranged to lie close to the gates instead of six feet in advance of them; and the tubes were shortened eight feet so that the immersed outlets would be but 10 feet below the surface of the water. With the changes made, the installation gave perfect satisfaction. The vents no longer clogged with frost; the pipes being in the path of the ascending bubbles were not weighted with ice; and the semi-circles of clear water in front of the gates were just wide enough to keep the ice away from the central two-thirds of each of them—in short, relieved them of pressure where they were least able to withstand it and reduced the pressure to an amount which would not overtax their designed powers of resistance. What was equally important, the ice elsewhere was left to bear against the dam and thus to anchor it so that it could not acquire menacing motion and momentum.

The entire insulation cost less than \$10,000 and the expenditure of air does not exceed 125 cubic feet per minute for the 119 submerged outlets. The labor charges during a season's operation are not more than \$100.

In the years that have intervened minor improvements have been made in the equipment, but the fundamentals have remained unaltered. A while back the manager of the Keokuk plant said the system was giving the greatest satisfaction and performing perfectly under extremely severe and trying ice conditions. And to think that these results are the outcome of a series of puny air jets. An aggregation of Lilliputians doing battle with a monstrous Gulliver.

### Current Psychic Investigation in Europe

(Continued from page 234)

"The author (Mr. James Black) concludes his series of slanders by an attack upon Eva's personality, referring to the fact that she is born in Algeria. He recounts that at Algiers a magnesium flashlight brought out the fraudulent behavior of the medium, an assertion clearly showing from what source his information is drawn. Before writing this, he was have done well to check better his information. No magnesium flashlight ever revealed anything about Eva. No confession in writing ever was made by her; there are no archives containing any records on this subject." (The Italics are ours.)

This denial leaves us with mixed reactions. To be sure, just such words might have

come from one whose emotions on the subject were extreme. But the equivocal and evasive tone of the italicized passages might equally well have been imposed upon the defence by the circumstances of the case. It would have been simple to make a categorical denial that Eva had ever practiced fraud under the name Marthe Beraud. Instead of this, it is insinuated without direct statement that the charges are badly founded; and we have then, not a clean-cut denial, but a mere catalog of two specific things that Eva did not do, followed by a very much out-of-place suggestion that whatever she may have done, there exists no proof. Such may not have been the intent of that last shot, but such is certainly its effect. The whole paragraph may impress the Gallic mind as a satisfactory denial; it does not so impress so much of the American mind as is represented by the Editor.

### Poisonous Metals on Sprayed Fruits and Vegetables

THE amounts of arsenic, lead, and copper remaining on mature fruits and vegetables which have been sprayed according to various schedules were determined in the Bureau of Chemistry. Because of over-spraying or late spraying comparatively large quantities of spray residues were found in some cases. This emphasizes the importance of spraying according to the schedules recommended by the Bureaus of Entomology and Plant Industry. The extent of the reduction of spray residues on the mature fruit and vegetables by washing and wiping them was determined by a series of analyses before and after such treatment. When peeled, sprayed fruits and vegetables contain essentially the same amounts of arsenic, lead, and copper as the unsprayed products, indicating that practically all of the spray residues can be removed by peeling. When fruits and vegetables are sprayed in accordance with the schedules recommended by the Bureaus, but little material used remains on the fruit or vegetable at harvest time.

### Twelve Months of Radio

(Continued from page 242)

and concert programs, for the taking of evidence, and for any purpose where a lengthy record of sound is required. It can be duplicated and used as a film phonograph and applied in radio telegraphy in producing wireless signals and for audio amplification. It has already been successfully applied in radio broadcasting.

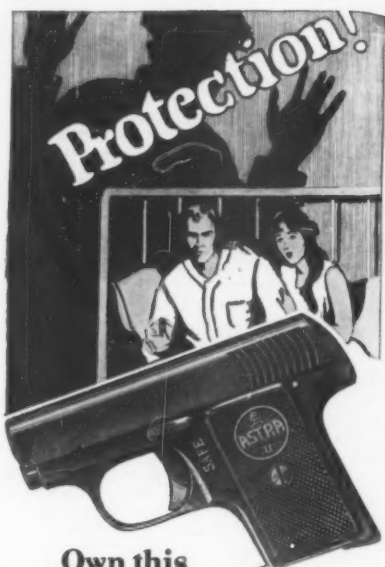
The largest vacuum tube ever made consists essentially of a water-cooled cylindrical anode 30 inches long and  $1\frac{1}{4}$  inches in diameter. In the axis of the anode is a tungsten filament 0.4 inch in diameter and 22 inches long. This filament is excited by current of 1800 amperes at 10,000 cycles, the filament excitation requiring about 20 kilowatts. The magnetic field produced by this large heating current is sufficient to cut off the electric current from the cathode to the anode during a portion of each half cycle of the current passing through the cathode, this action taking the place of that of the grid in three-electrode tube. The electron current to the cathode is thus interrupted 20,000 times per second. By the use of properly tuned circuits this can be used for the production of high-frequency power for radio or any other purposes.

This particular type of tube, which is called the Magnetron, will supply 1000 kilowatts of 200,000 cycle-power at an efficiency of 70 per cent, operating with an anode voltage of 20,000 volts direct current.

Complete carrier current equipment for telephone communication over the high tension transmission lines of power companies was developed and a number of sets were installed. The usual carrier current transmitter has an output of 50 watts and is rated at 75 miles, providing there are not a great number of tie-ins or transformer stations in this distance. The equipment includes a calling system whereby a bell is rung at the station called when the station calling actuates a push-button on the desk-stand forming part of the equipment.

Turning once more to the broadcasting side of radio, we find a new type radio receiving set with loud speaker which operates entirely by dry cells and has an equal or better reception range than the average two-stage set using storage batteries for the filament current. This set, in an attractive mahogany cabinet with none of the tuning or other knobs visible and with no external wiring except two silk covered cords reaching from the rear of the cabinet to the an-





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The ASTRA has heretofore always been sold through retail stores, but the competition of cheap cast-iron pistols has forced us to sell **DIRECT TO YOU, ELIMINATING THREE PROFITS—Jobber, Wholesaler and Retailer!**

**WARNING!** Cast iron guns are very dangerous! WE GUARANTEE THE ASTRA IS OF DROPPED FORGED STEEL THROUGHOUT! Before buying any weapon, **INSIST** on this guarantee. We also absolutely guarantee the ASTRA against inferior workmanship! If you are not entirely satisfied, return within 10 days and we will immediately refund your money!

**\$8.95** 25 CALIBER 7.62mm AUTOMATIC  
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Both Models Shoot Any Standard Ammunition—  
25 cal. model, 4 1/4 in. long by 3 1/4 in. high—an ideal gun for a man or woman. Substantial 32 cal. military model, 6 1/4 in. long by 4 1/4 in. high.  
Blue steel, beautifully balanced, swift—accurate! Superb workmanship and materials throughout. A gun that you will be proud to own. Protect your home and loved ones.

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tenna and ground, resembles nothing more than a long cabinet phonograph. It uses three of the latest type of vacuum tubes which consume but 60 milliamperes filament current per tube, or six one-hundredths of the current used by the present type storage battery tubes. The "A" battery, which is the storage battery in ordinary receiving sets, consists of three dry cells such as used for door bells. These supply the filament current at four and one-half volts. The "B" battery consists of four 22 1/2-volt units which supply 90 volts to the plate of the tubes. There is also a "C" battery, consisting of a small three-cell flashlight dry battery supplying four and one-half volts to the amplifier grid. This combination insures the highest quality of loud-speaker signals.

### Where British Patents Come From (Continued from page 250)

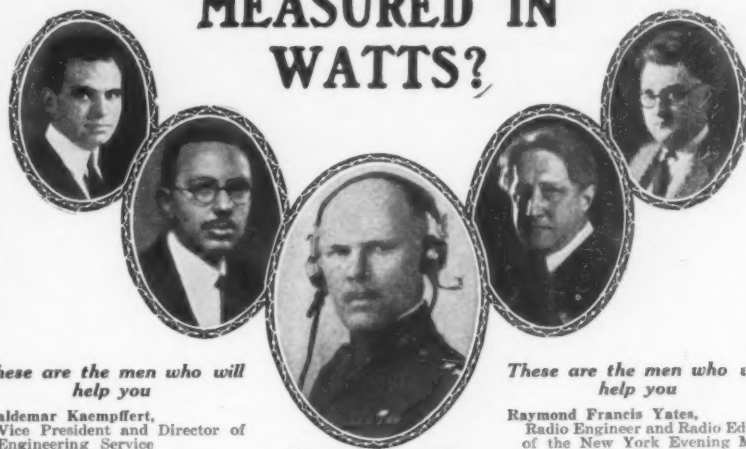
That men's thoughts, almost from the dawn of civilization, had turned to the possibility of emulating the flight of birds is proved by the numerous excerpts and sketches from ancient manuscripts, which are reproduced in that compendious work, "Aeronautica Illustrata," or "A Complete Cabinet of Aerial Ascents and Descents from the Earliest Period." Inserted in the Patent Library's copy of this collection is a fragment of the envelope of Montgolfier's original balloon, which ascended at Lyons on January 19, 1784. The Henson monoplane of 1842—which, as the illustration shows, bears more than a family likeness to the modern machine—is among the heavier-than-air flying apparatus treated of in this work. A print of great rarity and historical value is that of Thomas Savery's "Miner's Friend; or an engine to raise water by fire, described and of the manner of fixing it in mines." This print, published in 1702, depicts the first practical use of the steam engine. Savery became associated at a later date with Thomas Newcomen, 1663-1729, the inventor of the atmospheric engine, which was in use until superseded by James Watt's engines. "We are so familiar today with the reciprocating engine that we are apt to overlook the fundamental difficulty that faced the inventor," wrote a modern admirer of Newcomen's, "and that was the provision of some mechanism which would control the working fluid, so as to enable the engine to repeat its motions automatically an indefinite number of times. In fact the problem had never been tackled, and its solution was, in a very broad sense, the forerunner of all self-acting gears since invented."

Early efforts in a different sphere of mechanics are recorded by the specifications and prints of bicycles and velocipedes, among them being the "Early Hobby Horse," dating from 1818. Its inventor, Charles Baron Drais, wrote of it as follows: "It will travel up hill on a good footway as quick as a man can walk. Upon a level, even after a heavy shower, as quick as a post horse; upon a level and dry footway as quick as a horse in a gallop. Down hill as quick as a horse at full speed."

Two other gems of the library's collection may be briefly referred to. The first is a copy of Johann Cuba's "Ortus Sanitatis, auf Teutsch, ein Gart der Gesundheit," published August, 1485, and the earliest printed work in the library. Printing and paper are both excellent, bearing witness to the superb workmanship of those early craftsmen. The other is Leonardo da Vinci's "Codice sul volo degli Uccelli," which contains a facsimile of his sketch-book on the flight of birds. Although written from right to left, the Italian script is perfectly legible, while the original sketches reveal the hand of the consummate artist. Da Vinci was intensely interested in the problem of human flight, and his treatise on the theory of aerial motion would be sufficient of itself to ensure his lasting fame, even had he made no other contributions to art and science. These, however, are enshrined in his famous "Codex Atlanticus," in eight folio volumes, also in the Patent Office. The greatest scientific manuscript in the world, it covers most fields of applied science, and contains many surprising anticipations of modern mechanical inventions, including a machine for spinning, designed probably prior to 1500, which competent judges hold to be equal, if not superior, to Arkwright's water-frame, introduced about 1770.

One word in conclusion: Readers of the SCIENTIFIC AMERICAN should not omit, when next in London, to visit the Patent Office Library if they wish to spend a pleasant and profitable hour. Its home is in Southampton Buildings, near the top of Chancery Lane,

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Edited by Major-General Squier

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The quickest way to learn to swim is to get in the water, and the quickest way to learn about radio is to make a set yourself.

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These famous radio experts have prepared a brief complete course, giving in seven clear, graphic, fully illustrated lessons, everything that is known about radio. It is here offered you on most unusual terms.

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With these seven simple lessons any man or boy who likes to tinker can make himself a radio outfit that will be a source of constant entertainment to himself and family. Or if he prefers to buy his set, he can find out the best kind to get, and how to save money on his purchase.

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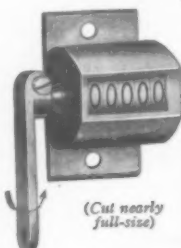


At left is shown a big new development in a Punch Press Counter; a heavy-cased, ratchet mechanism, immensely durable. Suitable as well for printing presses, and all heavy-duty machinery where a reciprocating movement of the machine registers an operation.

This counter requires no special fixtures for attaching. Strong stops limit the throw of the lever to 45 degrees or  $\frac{1}{2}$  turn, which registers one on the dial. The large, legible figures are easily read ten feet away. Counter is regularly furnished with 5 figure-wheels, and may be set back to zero by turning knob (at left) once round. Cut less than  $\frac{1}{2}$  size. Price, \$18.00.

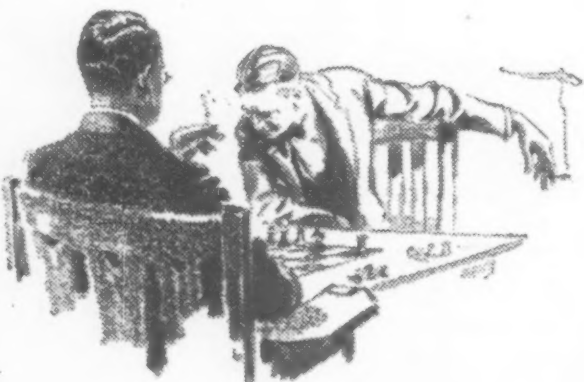
The small Rotary Ratchet Counter at right counts reciprocating movements of the lever, as required in recording the output of many small machines. When lever is moved through an angle of 40 to 60 degrees, the counter registers one. The further the lever is thrown, the higher the number registered. A complete revolution indicates ten. A very adaptable little counter at low price—\$2.00.

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### Fulfilling the Washington Naval Treaty

(Continued from page 253)

"Delaware," and "North Dakota," which, like the destroyed British ships, mount, each, ten 12-inch guns, and like them were completed between the years 1909 and 1911. The "Orion," "Monarch," and "Conqueror," 13.5-inch gun ships, were completed in the same year as our "Arkansas" and "Wyoming," which latter carry the 12-inch gun. In efficiency of battery they are about equal to our "New York," "Texas," "Nevada," and "Oklahoma," although these four ships were completed from two to four years later than the British ships.

In addition to the fleet of modern ships represented by the 18 dreadnoughts which Great Britain in accordance with the Washington Treaty, has broken up, disabled, or sold out of her fleet; she has also scrapped another and enormous fleet of warships, and she has done this voluntarily and independently of any Treaty requirements. Realizing at the signing of the Armistice that her war task was done, Great Britain at once set about the reduction of her fleet to peacetime requirements. From November 11, 1918, to December 16, 1922 (the date on which our statistics were secured from the Admiralty), Great Britain has either destroyed, or rendered incapable of war service, and sold for breaking up, a fleet that ran up to a total of 619 ships. This total does not include the 18 dreadnoughts and battle cruisers, nor 20 battleships, submarines, etc., that have been dismantled and are still up for sale. If these be included, the grand total of ships that have been scrapped by the British since the Armistice is 657.

Of ships destroyed independently of the Conference the most important are 24 predreadnought battleships, chief among which are the vessels of the "Lord Nelson" and "King Edward" classes, carrying 12-inch and 9.2-inch guns, a group of ships that is comparable to our own "Connecticut" class.

Next on the list come 32 cruisers, armored and unarmored, and the most modern of them comparable to our own armored cruisers of the "Seattle" and "Huntington" classes.

In the valuable light cruiser class, a vessel which proved its efficiency in the various engagements of the war, Great Britain has scrapped no less than 54.

One of the most modern types of vessel developed during the war and recognized as an indispensable unit in destroyer warfare is an enlarged and powerful destroyer known as the "flotilla leader." It is a thoroughly modern vessel, and of these Great Britain has scrapped ten having speeds of from 31 to 34 knots. As for destroyers, she has here made practically more than a clean sweep of her whole destroyer fleet as it existed in 1914, for she has scrapped a fleet of 275 of these craft. Also she has got rid of her torpedo boats to the number of 95.

During the war she designed and built some entirely new vessels of the monitor type. These were intended for special off-shore work and were used in various theaters of war, but principally in the bombardment of the ports of Ostend and Zeebrugge. They were among the first vessels to carry the anti-torpedo bulge, and many of them were armed with modern 14-inch guns. There were 20 of these vessels, and all of them have been scrapped.

Most surprising of all to many of us will be the announcement that the Admiralty has scrapped a total of 105 submarines, and that 11 others have been dismantled so as to be useless for war service, and are now on the sale list.

Finally, four of the aircraft carriers that were built or extemporized during the war have also been stricken from the list.

In addition to the above vessels, the following ships have been disabled and are on the sale list; namely, five battleships, cruiser and light cruiser, two destroyers, and the eleven submarines above mentioned.

It should be made clear that it is not

obligatory for any of the three naval powers concerned to scrap any of their ships until the Treaty has been ratified by the five nations concerned, and this will account for the fact that our own Navy Department has broken up two predreadnought battleships only; namely, the "Maine" and "Missouri." Although the five predreadnoughts of the "Virginia" class were for some time listed for sale, they have recently been withdrawn until such time as the French shall have signed the Treaty. To our credit, however, is to be placed the fact that we have ceased construction on 12 dreadnoughts represented by six mighty battleships of the "North Dakota" class and the six battle cruisers of the "Lexington" class. These, except the two which are being completed as aircraft carriers, will be broken up when the Treaty is fully ratified.

Of the Japanese ships, the seven predreadnoughts "Hizen," "Mikasa," "Katori," "Kashima," "Ikoma," "Ibuki," and "Kure," are having their guns and turrets removed, and in some cases the armor has been taken off these ships and their engines dismantled. The hulls will not be broken up or sunk until the Treaty is ratified by all the powers. Like ourselves, they have ceased construction on the large battleships and battle cruisers that were on the ways when the Treaty was negotiated.

### Short-Time Tests for Long-Time Endurance

(Continued from page 264)

its axis, the radius of the circle being the deflection corresponding to the desired stress.

Differential copper-constantan thermocouples were used to measure the rise of temperature. One couple was attached at the section of greatest stress,  $K$ , and held directly against the specimen by means of tape. The opposing couple was at  $L$ , a section of zero stress, and was electrically insulated from the specimen by a single layer of thin paper. The couples were connected so as to oppose each other and in series with a D'Arsonval galvanometer. When the couples were at the same temperature no deflection of the galvanometer was shown, but when there was a difference of temperature a corresponding deflection occurred. This arrangement proved very satisfactory and calibration showed it to be sensitive to 0.00286 degrees Centigrade.

The test adopted as a standard consists in running the machine at 1000 r. p. m. for 30 seconds, using a known stress and recording the maximum deflection of the galvanometer. Then with a series of such readings, corresponding to a series of stresses, a curve is plotted to show the increase of temperature with the increase of stress.

It is found that in each curve there is a slight break considerably below the abrupt break of the endurance limit. It is probable that there is at this point a very slight incipient damage in some weaker constituent, but that the load is still sustained by the stronger constituent and no failure, as shown by actual tests, results until the higher stress is reached. This first break decreases in amount with an increase of the carbon content in the normalized steels and is also smaller when the steel has been given such heat treatment as to produce a sorbitic structure. It would then seem that this first break may depend upon some property of the ferrite crystal and so may decrease in sharpness with a decrease in percentage of ferrite and with a more complete dispersion of cementite, such as occurs in sorbite.

It may be possible that this first break indicates the absolute endurance limit, i. e., the stress under which the material will withstand an infinite number of repetitions. This, of course, cannot be checked by actual applications of stress, but it is not impossible to conceive that, at the endurance limit determined by tests to one hundred million repetitions, the curve may still have a very slight downward trend, which, if the tests were carried to billions of repetitions might bring the endurance limit to the value shown by the first break of the temperature curve.

Comparison of endurance limits as determined in the rotating-beam machine and in the temperature machine shows a very good degree of coincidence. The value of such a machine quite evidently lies in its possibilities for a commercially available fatigue test of materials and in the possible application of the principle of the working parts of machines while under running conditions. Another favorable property is that the test is not destructive and could be applied to the actual material or machine part which would be later safely used in the normal way.





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